QUINHAGAK, ALASKA
Kanektok River Erosion Study

February 2019

Prepared for:
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References

Herrera Environmental Consultants, *Preliminary Hydraulic Report – Quinhagak Erosion Mitigation Planning Study*, February 25, 2019.

Office of History and Archaeology, Department of Natural Resources, State of Alaska. Kanektok River System Final Interim Summary Report. 2010.

1. Introduction

The community of Quinhagak is threatened by riverine erosion along the reaches of the Kanektok River north of the community. Qanirtuuq Incorporated, has retained CRW Engineering Group, LLC and Herrera Environmental Consultants to perform a hydrologic and hydraulic analysis of the Kanektok River to gain a better understanding of the river dynamics and to evaluate potential erosion mitigation measures.

During the summer of 2018, the project team conducted a topographic and bathymetric survey of the Kanektok River. The survey data was used to perform a hydrologic analysis of the river flows. Based on the survey and hydrologic data, a hydrodynamic model was then created to analyze river hydraulics. The model was used to analyze several different erosion mitigation scenarios further discussed in this report.

Included in Appendix B is the draft "Preliminary Hydraulic Report" by Herrera. Information from this Herrera report is heavily excerpted and referenced throughout this study.

Photo 1- Pegati Lake (Photo by CRW Engineer Andrew Gallagher)

2. Background

2.1.1 Geologic Setting

The beaches to the south and west of Quinhagak are largely made up of layers of riverine and ocean sediments. The materials underlying the community are typical of the area and similarly include coastal deposits of inter-layered alluvial (river) and marine sediments and coastal delta deposits (Herrera 2018). The former runway rests of alluvial deposits in the floodplain of the Kanektok River.

2.1.2 Kanektok River System

The headwaters of the Kanektok River are the Kagati and Pegati Lakes. The river runs approximately 90 miles from the Eek and Ahklun Mountains westward, wrapping around the northern part of Quinhagak just before entering the Kuskokwim Bay. The uppermost 70 miles of the river fall within the Togiak National Wildlife Refuge Area and are designated as "wilderness." The river is generally braided, with gravel bars, and islands throughout its course. For the majority of its course, the shores of the river are lined with thick stands of willow, cottonwood and alder trees.

River freeze-up usually occurs between late October and late November. Break-up generally occurs between late-March to late-April. The mouth of the river is characterized by muddy tidal flats. It is common for barges to miss bends in the channel and run aground until the next tidal cycle.

The Kanektok River basin has significant cultural and economic importance to the community of Quinhagak. The drainage plays a critical role in subsistence activities, including the harvest of moose, small game, waterfowl and salmon. Guided fishing also occurs along the river during the summer months.

The river's name "Kanektok" is a variation of the name of the community at the river's mouth - "Quinhagak." In the early 1900s, U. S. Geological Survey (USGS) geologist G.L. Harrington reported that the name Quinhagak means "new formed river," referring to "the constantly changing channel of the stream on which the village is located."

3. Technical Approach

3.1 Stakeholder Communications and Public Meetings

The project team traveled to Quinhagak in early June 2018 to conduct the first public project stakeholder meetings. A second project stakeholder meeting was conducted in September 2018 to present the draft hydraulic report. Copies of trip reports are included in Appendix A.

3.2 Topographic and Bathymetric Surveys

During the June 2018 site visit, the project team collected data on the river, including an updated orthorectified photograph and a bathymetric survey. The orthorectified photograph was created using an Unmanned Aerial Vehicle (UAV), and the bathymetric survey was conducted using a Seafloor Systems Hydrolite-DFX dual frequency Eco sounder.

The UAV utilizes on-board survey-grade global positioning system (GPS), which communicates with a ground based GPS station to capture images that are georeferenced to centimeter accuracy. The images were then imported into 3D software to create an orthorectified photograph.

To conduct the bathymetric (hydrographic) surveys a Seafloor Systems Hydrolite-DFX dual frequency Eco sounder was utilized, which penetrates through soft sediment to detect the hard bottom as well as the surface layer. The sounder interfaces directly with the Leica GPS units to record the bathymetric data points. The horizontal and vertical and accuracy of the point bathymetry data points averages 0.1 feet (1/10 foot).

Existing LiDAR-based survey data was updated based on the orthorectified photographs to capture changes in the river morphology and merged with the bathymetric survey to create a composite survey surface.

3.3 Hydrologic and Hydraulic Analyses

The hydrological analysis was used to estimate river flows using the USGS regression equations for Alaska, along with upstream basin delineation using the LiDAR-based survey data. The Eek Channel tidal charts, calibrated with local knowledge, were used to determine the downstream boundary conditions. Additional information on the analysis of the watershed and calculated values for the 2-year flows (9,400 cubic feet per second) and 100-year flows (21,200 cubic feet per second) is included in the attached draft report by Herrera in Appendix B.

Once compiled, the survey and river flow data was entered into RiverFlow2D program, a finite element hydrodynamic model that analyzes river hydraulics. The RiverFlow2D model uses a triangular unstructured mesh to capture the dimensional hydraulics of the river, uses an optimized computation engine for faster runs, and estimates erosion and deposition processes along the river. Once established, the model was modified to analyze the river hydraulics with different mitigation scenarios in place. The model results are included in the draft Herrera report and generally summarized in this study.

4. Discussion of Kanektok River Erosion

4.1 Areas of Erosion

4.1.1 End of Former Runway

The eastern end of the former runway is identified has the most pressing erosion concern for the community. While this area may have seemed like a good location for gravel extraction, those actions have made this area vulnerable to increased erosion and any removed fill should be replaced to help minimize future erosion. According to the Herrera analysis, the river could occupy the runway at this location which could cut-off the nearby access road to needed gravel sources and allow the river to run closer to existing buildings including the school. As recommended in the Herrera report, this area should be refilled to the level previously excavated to provide some level of mitigation. This area will continue to erode until a long term erosion mitigation measure is installed.

Photo 2 – Erosion at End of Former Runway

4.1.2 Former Runway

The erosion along the former runway has been the greatest concern of the community. When this runway was originally constructed, the gravel used to build the runway was taken from between the runway and the river. It is thought that during the 1990s a large storm event overtopped the gravel pits in this area effectively rerouting the river to run adjacent to the runway. Overtime, the river began to erode the runway, requiring the construction of a new runway to the south and east, further from the river (see Figure 1). As erosion along the former runway worsened, the community installed supersacks to slow the erosion. This has only been temporarily effective.

As discussed in the Herrera report, the combination of lack of vegetation along the runway, loosely layered sediments (alluvium substrate) and the high velocities in the river, mean that erosion along this area is expected. Similar to concerns at the east end of the runway, this area has the potential to allow the river to access low ground and create a new channel closer to the community. It does not appear that this would be an imminent risk to the community but does present a long-term risk that should be addressed.

4.2 Other Areas

Several other areas of erosion concern, including the access road to the water, barge landing (port) and river mouth and gravel pits are discussed in Herrera's report in Appendix B.

5. Discussion of Mitigation Measures

Mitigation measures include both long term (river rerouting) and short term to address immediate erosion concerns (bank protection). The various alternatives are shown on Figure 2 and summarized in the following sections.

5.1 Long Term – River Reroute Alternatives

5.1.1 Alternative 1 – Mid Route

This alternative would require excavation of a small section of high ground to connect the river to what is referred to as the 1950's Channel (see Figure 1). Additional excavation would be needed to ensure this new diversion channel was positively draining. As noted in the Herrera study, two variations of this alternative (1a and 1b) were modeled. The alternatives are essentially the same as they both incorporate excavation of the ridge to allow the river to achieve a bottom width of 40 feet. Alternative 1b includes construction of a berm to restrict return flow. Use of this berm in the model provides a better performing reroute alternative. Both 1a and 1b are within a single native allotment (US Survey No., 9665-2).

5.1.2 Alternative 2 – North Route

As can be seen on Figure 2, this alternative also seeks to send the river to the 1950's Channel but along a more direct route. The alternative is in a single native allotment (US Survey No. 9665-1).

5.1.3 Alternative 3 – South Route

The Alternative 3 reroutes the river downstream from the locations in Alts 1 & 2 and does not use the 1950's Channel. This is a shorter reroute and wouldn't require as much excavation. The alternative is on two native allotments (US Survey No. 9672-5 and No. 9672-8).

5.2 Short Term – Bank Protection Alternatives

5.2.1 Alternative 4 - Riprap

Alternative 4 includes the placement of riprap along the former runway (1,500 ft) including the end section (300 ft). As modeled, it assumes the riprap runs along the entire height of the bank at a 2H:1V slope into the river.

5.2.2 Alternative 4.1 – Riprap at End of Runway

Alternative 4.1 includes placing riprap just at the end of the former runway. This scenario was not modeled but was identified for cost estimating purposes.

5.2.3 Alternative 5 - Super Sacks

Alternative 5 includes erosion protection along the most vulnerable 900 ft of former runway using super sacks. Super sacks are obviously not as solid as riprap and would not provide the same level of protection. However, they can provide a less-expensive, effective short-term solution to acute erosion problem. In addition to placing super sacks along and at the end of the former runway, the area near the end of the former runway should be infilled to restore the original grade and reduce impacts from the river potentially overtopping this area. Initial correspondence with the Alaska Department of Fish & Game (ADF&G) indicated their reluctance to permit super sacks for this area. If the community decides to pursue this alternative, additional discussions will be required.

5.2.4 Alternative 5.1 – Gabion Baskets

Under this alternative, gabion baskets would be used for bank protection in lieu of the super sacks. The gabion baskets would be filled with local gravel materials and deployed along the north and east end of the old airport. The gabion baskets would provide a longer term solution that the super sacks, however they would not be as robust or last as long as the riprap alternative. Similar to Alternative 4.1, this scenario was not modeled but was identified for cost estimating purposes.

5.3 Long Term & Short Term – River Reroute & Bank Protection

5.3.1 Alternative 6 – River Reroute & Riprap

This alternative is a combination of Alternate 1 and Alternative 4. This option, while the most expensive, offers the greatest chance of long term protection to the water access road and gravel sites, reduced erosion along the old runway, and increased protection of community facilities from this continued erosion. The river would be rerouted as proposed in Alternative 1 and riprap would be placed the entire height of the bank for 1,500 ft along the runway and 300 ft at the end, as proposed in Alternative 4.

6. Model Results

6.1 River Reroute Options

6.1.1 Alternative 1 – Mid Route

The modeling results for Alternative 1 indicate that flows in the new diversion channel could be maintained and that the channel could widen over time. This option could result in decreased velocities near the old runway, potentially causing abandonment of the main channel between near where the channel was previously diverted and the 1950's channel. The lack of significant changes in the velocities downstream of the 1950s channel could mean that downstream impacts will be minimal. This could change over time as flows move and deposit sediment in the area.

6.1.2 Alternative 2 – North Route

Alternative 2 has a steeper slope than Alternative 1 however the model showed that this option proved to be much less effective at diverting flow. It did not alter velocities in either the 1950s channel or the main channel meaning that overtime, the area could fill in and not be a sustainable river reroute.

6.1.3 Alternative 3 – South Route

The Alternative 3 model results were similar to Alternative 2. The reroute option did not divert sufficient flows from the main channel to the 1950s channel and is therefore deemed an unsustainable option.

6.2 Bank Protection Options

6.2.1 Alternative 4 - Riprap

The model results for Alternative 4 indicate minimal downstream impacts caused by the placement of riprap. This is likely because of the small area of riprap relative to the width of the river. This alternative would provide bank protection but could generate some local erosion at the downstream end of the riprap.

6.2.2 Alternative 5 – Super Sacks & Gabions

Alternative 5 is essentially a scaled-down version of Alternative 4 and impacts are similar.

6.3 Reroute & Bank Protection

6.3.1 Alternative 6 – Mid Route & Riprap

This alternative essentially matches the model results of Alternative 1 – Mid Route and Alternative 4 - Riprap. Over time, it would be expected that the rerouted river would migrate away from the edge of the runway effectively reducing the risk of erosion to the community in that area. Installing riprap along the runway would provide an immediate benefit to the community while the rerouted river eventually returns to the 1950's channel.

7. Permitting & Site Control

7.1 Alaska Department of Fish and Game (ADF&G)

The Kanektok River is an anadromous water body, with runs for various salmon species. Activities such as bank stabilization and channel rerouting would require a Fish Habitat Permit from ADF&G. It will be important to engage ADF&G early in the design process.

Photo 3 - Upper Reaches of Kanektok River (Photo by CRW Engineer Andrew Gallagher)

7.2 United States Army Corps of Engineers (USACE)

Section 10 of The Rivers and Harbors Act of 1899 regulates the placement of any structure or in, under or over a "traditionally navigable water." Section 404 of the Clean Water Act regulates discharge of dredge material of fill material into "waters of the US", including adjacent wetlands. All the alternatives, including placement of bank protection or the reroute of the river channel would require a permit from the USACE.

Nationwide permits are typically limited to less than a half-acre of impact or less than 300 to 500 linear feet. Alternatives 4.1 and 5.1 would affect less than 500 linear feet and would likely be eligible for a nationwide permit. The remaining alternatives, however, would affect an area or length greater than the permit limits, and it's likely that a Section 401 permit would be required. Any river reroute option would have the potential to increase sedimentation at the mouth of the river and future dredging in this area should be considered and discussed with USACE. Much like ADF&G, the USACE should be engaged early in the design process.

7.3 Department of Natural Resources (DNR)

Coordination with the Department of Natural Resources (DNR) would be required for any of the channel reroute alternatives. Land adjacent to navigable water maintains riparian rights which are defined as rights to the water itself or its use, and rights incident to the land that may include ownership of, or use of the bed, or rights to acquire additional formed by water action (accretions). In a nutshell, any changes to the land adjacent to the river associated with a river reroute will need to be coordinated with DNR. Much like the other permitting agencies, DNR should be engaged early on in the project planning.

7.4 Alaska Department of Environmental Conservation (ADEC)

A construction general permit authorizes storm water discharges from large and small construction-related activities that result in a total land disturbance of equal to or greater than one acre and where those discharges enter waters of the U.S. (directly or through a storm water conveyance system) or a municipal separate storm sewer system leading to waters of the U.S. subject to the conditions set forth in the permit. The permit also authorizes storm water discharges from certain construction support activities and some non-storm water discharges commonly associated with construction sites.

A construction general permit would be required for any of the proposed channel reroute alternatives. The bank protection alternatives would likely be less than an acre and as such not require a permit.

7.5 Site Control

All of the river reroute alternatives cross one or more native allotments (NA). Alternative 1 would cross a single native allotment on US Survey No. 9665, Lot 2. The owner of this allotment is Moses Fox. Mr. Fox is deceased, his wife is Annie Fox. Alternative 2 would cross a single native allotment, US Survey No. 9665, Lot 1. The owner of this allotment is Martha Oldfriend. Alternative 3 would cross two native allotments: US Survey No. 9672, Lots 5 and 8. The owner of both these lots is John Johnson.

An easement or other form of site control across each of the respective native allotments would be required for any of the channel reroute alternatives. Initial coordination with BIA and DNR will be crucial to advance any of these options.

The bank stabilization options (Alternatives 4, 4.1, 5, 5.1 and part of 6) would all be located on US Survey No. 9672, Lot 6 which is owned by Qanirtuuq, Incorporated. The following table summarizes the site control requirements that could be associated with each alternative.

Table 1 – Site Control Requirements

Alternative	Site Control Needs
Alternative 1 – Mid Route	Native Allotment – US Survey No. 9665, Lot 2
Alternative 2 – North Route	Native Allotment – US Survey No. 9665, Lot 1
Alternative 3 – South Route	Native Allotment – US Survey No. 9672, Lots 5 & 8
Alternative 4 – Riprap	Qanirtuuq Inc. – US Survey No. 9672, Lot 6
Alternative 4.1 – Riprap only at End of Runway	Qanirtuuq Inc. – US Survey No. 9672, Lot 6
Alternative 5 – Super Sacks	Qanirtuuq Inc. – US Survey No. 9672, Lot 6
Alternative 5.1 – Gabion Baskets	Qanirtuuq Inc. – US Survey No. 9672, Lot 6
Alternative 6 – Mid Route & Riprap	Native Allotment – US Survey No. 9665, Lot 2 and Qanirtuuq Inc. – US Survey No. 9672, Lot 6

8. Cost Estimates

Capital cost estimate for the various alternatives are presented in the table below. Cost estimates are presented only for comparison purposes between the alternatives. A preliminary design would be required to generate cost estimates that would better represent construction costs.

Table 2 – Capital Costs

Channel Reroute	
Alternative	**Cost**
Alternative 1 – Mid Route	$2,090,000
Alternative 2 – North Route	$2,305,000
Alternative 3 – South Route	$1,247,000
Bank Stabilization	
Alternative	**Cost**
Alternative 4 – Riprap	$2,650,000
Alternative 4.1 – Riprap only at End of Runway	$1,071,000
Alternative 5 – Super Sacks	$937,000
Alternative 5.1 – Gabion Baskets	$2,153,000
Channel Reroute & Bank Stabilization	
Alternative 6 – Mid Route & Riprap	$4,416,000

9. Funding Sources

Funding for any of the alternatives could come from a combination of local, state and federal sources. The USACE has historically provided funding for river reroute projects through their Continuing Authorities Program (CAP) Section 205 – Small Flood Damage Reduction Projects. The maximum federal expenditure under this program is $7 million including studies, design and construction. All of the alternatives, including Alternative 6, fall under the funding threshold. The CAP Section 205 projects are competed for nationally so funding is not guaranteed. However, if the initial written request to USACE is approved, the study is initiated with up to $100,000 in federal funds. Costs that exceed $100,000 are shared 50 percent federal and 50 percent sponsor (could be state, local or even another federal agencies as long as they grant permission to the USACE to take the lead). If the project is deemed feasible, the USACE can fund up to 65 percent of the design and construction. The remaining 35 percent could be a combination of state, local or federal assuming the appropriate permissions are granted.

Another funding source could include FEMA's Pre-Disaster Mitigation (PDM) Program. Similar to USACE's CAP, projects under FEMA's PDM are also competed for nationally. The PDM requires that the project be previously identified in a local Hazard Mitigation Plan and participation in the Federal Flood Insurance Program (FIP) is generally required. An application is completed, including the determination of the benefit-cost analysis using FEMA's software. If the project is accepted, design and construction funding of up to 90 percent could be provided by FEMA. The 10 percent match could be provided by local or state funds.

10.Conclusion and Recommendations

The recommended alternative is a phased approach that combines two of the alternatives.

For the short term (immediate term), Alternative 4.1 – Riprap only at End of Runway is recommended to provide protection of the old airport runway. Riprap would be placed at the east end of the runway and low lying areas would be infilled to restore the original grade and prevent the river from overtopping the area should the end of the airport be breached. These immediate term measures will provide some degree of protection against erosion until longer term measures can be implemented.

For the long term, the Alternative 1 – Mid Route channel reroute is recommended. Hydraulic modeling of this alternative indicates that the channel reroute will be self-sustaining. The reroute will shift the river back to the original 1950's channel, restoring the previous historical path of the river. This alternative will also create additional fish habitat and riparian areas. Most importantly, this alternative will reduce velocities along the areas of erosion concern at the old airport.

If Alternative 1 cannot be funded or implemented for permitting or site control reasons, the community should consider Alternate 4 – Riprap which would provide erosion protection along and at the end of the old runway.

AERIAL PHOTOGRAPH: MAY 2015

PROJECT: 81103.00
STATUS: FINAL

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#AECL882-AK

KANEKTOK RIVER
QUINHAGAK, AK
KANEKTOK RIVER EROSION STUDY

DATE	FEB 2019
SCALE	AS SHOWN
FIGURE	1

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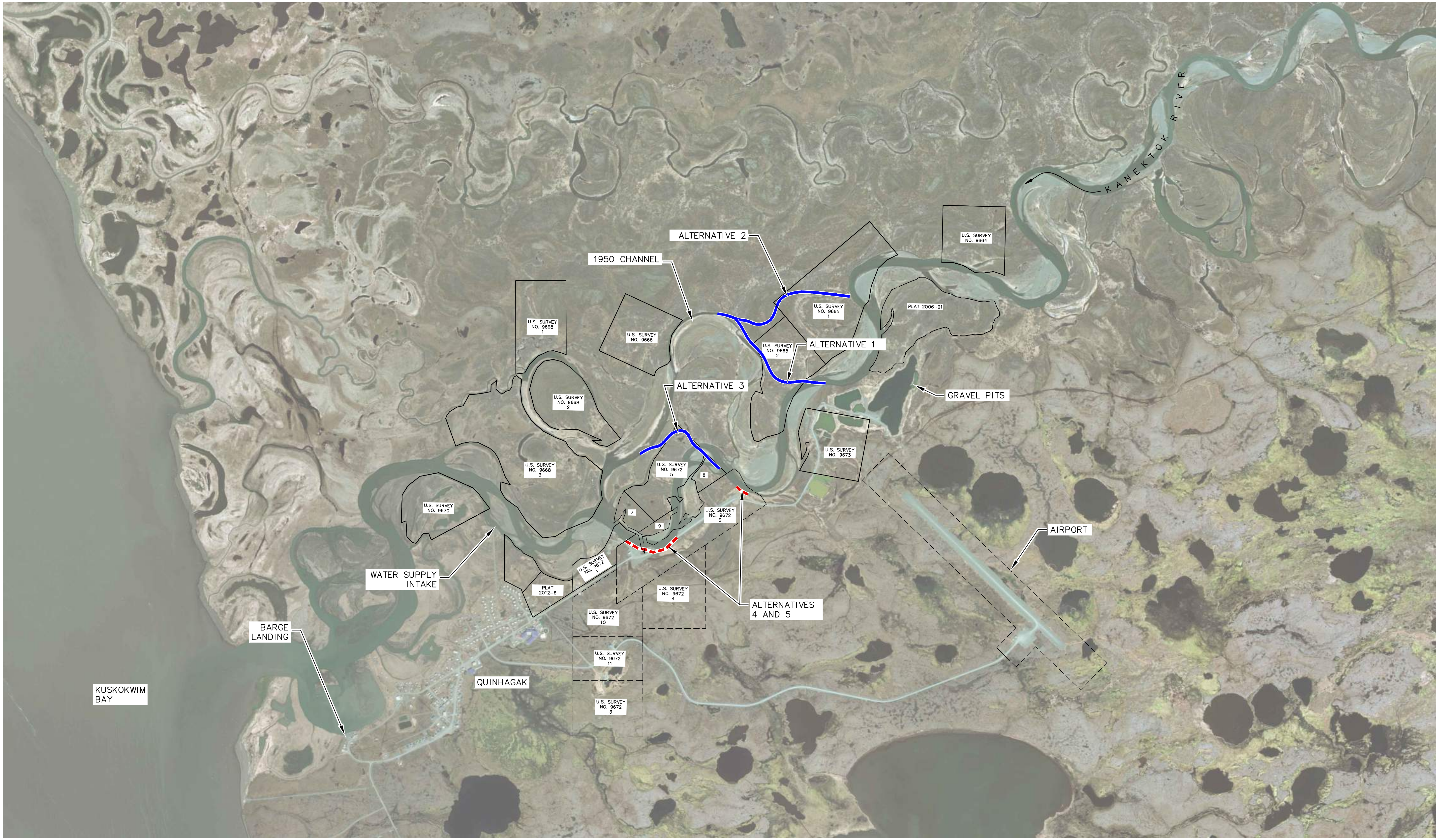

AERIAL PHOTOGRAPH: MAY 2015

LEGEND

CHANNEL REROUTE (ALTS 1, 2 & 3)

BANK PROTECTION (ALTS 4 & 5)

NATIVE ALLOTMENT

US SURVEY OR PLAT BOUNDARY

1000' 0 1000' 2000'

PROJECT: 81103.00

STATUS: FINAL

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3940 ARCTIC BLVD, SUITE 300
ANCHORAGE, ALASKA 99503
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#AECL882-AK

ALTERNATIVES NO. 1-5

QUINHAGAK, AK

KANEKTOK RIVER EROSION STUDY

DATE
FEB 2109

SCALE
AS SHOWN

FIGURE
2

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Appendix A

Trip Reports and Meeting Notes

Included in this section:

1. Trip Report, Andrea Meeks, CRW Engineering Group, June 4 – June 7, 2018
2. September 17, 2018 Community Meeting Flyer and Sign-in Sheet

TRIP REPORT

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Project:	Kanektok River Study – 81103.00
Purpose:	Site Visit, Survey & Community Meeting
Date:	Monday, June 4 – Thursday June 7, 2018
People Traveling:	Andrea Meeks, CRW Anthony Robinson, CRW Michael Spillane, Herrera Jeff Parsons, Herrera Gretchen Kayser, Herrera
Location:	Quinhagak, Alaska
Contacts:	Warren Jones, Qanirtuuq Corporation (Q Corp)General Manager Carl Nicholai, Q Corp Land Planner Frank Hill, Q Corp Employee & Yute Agent Teddi Smith, Q Corp Employee Ferdinand Cleveland, Native Village of Kwinhagak (NVK) Tribal Administrator Jonathon Alexie, City of Quinhagak Public Works Director Stephan Jones, NVK, Environmental Coordinator John O. Mark, Resident Paul Trader, Resident James Williams, Resident John Matthew, Resident Mary Matthew, Resident John Hunter, Resident
Reporter :	Andrea Meeks

<u>Activities</u>

Monday, June 4, 2018

Tony and I caught the 9:45am Ravn flight to Bethel but our bags didn't. We met Michael, Jeff and Gretchen in Bethel and waited for our bags to arrive. We flew to Quinhagak around 5:00 pm. After getting settled in, we used the Q Corp van to give our Herrera team members a tour of the community. Observations and notable findings are listed at the end of this trip report.

The Kanektok River levels were the highest that I have ever witnessed personally. The road to the water source intake was inundated by water from the river. The riprap down at the intake appears to be in good shape and protecting the facility. The water level is so high that we were only able to observe the first few layers of rock. Hooligan (?) were jumping like crazy. Only the tops of the brush on the gravel bar in the middle of the river in this vicinity were visible. The river was full and moving fast. Jeff estimated the flow to be between 7,000 and 9,000 cubic feet per second. We returned to our lodging, had dinner and called it a night.

Tuesday, June 5, 2018

We got up early for kuviag (coffee). Warren came in and we had a good discussion about the river. According to Warren, George Pleasant's grandmother was shaman who had predicted the community would move 5 times and their fifth spot would be final. The current location of the community is their third. Warren tells us of the little Kanektok River north of the main river. We discuss the borrow pits, old and current, options for rerouting the river, potential for future impacts from Julia Williams' and Q Corps, gravel pits. Michael recommends we identify the hazards of the river continuing to erode and then explain how rerouting or armoring would help or hinder those hazards. Tony, Mike, Gretchen and Jeff head to the river for the bathymetry survey while I start setting up interviews with local residents. I meet with Bob White who is in town with Brian Lefferts (YKHC), Andy Lean (ANTHC) and Mia Heavener (ANTHC) to inspect the Lifewater Wastewater Treatment Units that we installed in 2016.

I checked in with Ferdinand Cleveland at NVK to discuss the W&S system including the pending lead and copper corrosion study, the new leveling work, and the status of NVK's heavy equipment. Ferdinand shares some names and numbers that might provide good information on the river. I met briefly with Jonathon Alexie and Pat Cleveland to discuss the Utility Building, heat recovery system and the W&S system. I set up interview times with Paul Trader, John O. Mark, John Matthew and James Wiliams for Wednesday morning.

Wednesday, June 6, 2018

Tony gets back on the river to continue the bathymetry survey, while Jeff, Michael, Gretchen and I head out to conduct interviews with residents about the history of the river. We continue to hear about the prediction that the community will move 5 times before staying put. After the interviews we headed back to the Q Corp building for lunch. Warren requested that we reschedule the community meeting to accommodate the NBA finals. The word gets distributed and we head to the Bingo Hall for the 4:00 pm public meeting.

The meeting turnout is excellent. Anthony Caole is able to call-in and participate. Thanks to Warren/Q Corp for donating the fuel for the door prizes. Andrea provides a brief summary and then introduces Jeff and Gretchen, who explain how the survey data will be used to model the river and identify mitigation measures. Residents are concerned about the river cutting through the old runway, impacting the village and destroying access to gravel. They are also concerned about the City Dock silting in and the impacts of not getting fuel and goods. Jeff, Gretchen and Michael explain that these are connected actions and ask the community to consider where they would get gravel and/or barge in goods if the City Dock silts in and road to the gravel sources gets destroyed. The community indicates that the Arolik River (south of the community) could be a possible site for a new dock and a source of gravel. Local resident John N. Fox, addressed the group in Yupik and reminded everyone about the prediction that Quinhagak would move five times and they are on the third move. In general, it appeared that the residents were in favor of supersacks and riprap (particularly since it's holding up well at the intake site) but didn't seem too interested in rerouting the river. If possible, the river rerouting could potentially occur across a Native Allotment partially owned by Annie Fox and Family and by Mary Matthew and her siblings. Mary provides me with contact information for these people. We distribute the Stakeholder Communication Plan and the meeting ends at 6:30 pm.

Jeff, Michael, Gretchen and I meet up with Tony at the Old Village site and ride to the mouth of the Kanektok. We see a skiff tied up and getting submerged. Tony, Michael and Ilani (our boat operator) bail out the water and save the boat. We boat down to the old runway, noticing the erosion around Service Area 7, and the incredibly high water level near the intake and old runway.

Mary and John Matthew have us over for moose stew and akutaq. Quyana!

The team takes one more drive around the community, checking out the Arolik River and then we call it a night.

Thursday, June 7, 2018

We wake up to a cloudy day. A low ceiling in Bethel has planes on weather hold. This gives us the chance to visit with Teddi Smith, John Hunter and Frank Hill. John said that when the bluff at the City Dock used to erode, they could hear the land fall off and into the river. After some rebooking, we catch later Ravn flights out of Quinhagak. Gretchen, Michael and Jeff take the late AK Air jet to Anchorage. I catch the evening Ravn flight.

Observations & Notable findings:

1) It appears that gravel is being mined from the end of the old runway. Herrera makes it clear that this practice should stop because it has the potential to increase erosion and make things worse in the area.
2) A fuel barge was turned away because it couldn't access the City Dock (too shallow from silt).
3) The community is in support of either super sacks or riprap along the old runway.
4) The road to the landfill needs more gravel and to be regraded.
5) The landfill needs general maintenance and clean up. The community would benefit from a scrap metal/junk vehicle clean up. There may be IGAP funds available for this type of project.
6) The lagoon access gate was locked (good).
7) The force main has jacked/settled near the lagoon.

Attachments: Site Visit Photos (2 pages)

Surveying the Kanektok River

High water on the Kanektok River

Old Runway Eroding and High water on the Kanektok River

Erosion at the north end of Service Area 7

Notice of Community Meeting

Where: Bingo Hall

When: Monday, September 17th, 6pm – 7pm

Why: To Discuss the Ongoing Kanektok River Study

Who: Qanirtuuq Inc., CRW Engineering Group & Herrera

Please come to the community meeting to discuss the results of the Kanektok River Study!

CRW and Herrera will be in town presenting the hydraulic model results and the draft report.

Your input is important for this project to succeed.

Looking forward to seeing everyone!

9/17/2018 KANEKTOK RIVER EROSION STUDY

STAKEHOLDER UPDATE MEETING

Moses Guest

[illegible] Gilbert

Matthew Friendly

[illegible] L. Hill

John Hunter

Annie Brittom

Louisa Britton

Wanna [illegible]

Stanley Hawk

Annie Fox

Oto Guest

Lucy Carter

Jimmy Anaver

Annie Roach

Annie Joseph

Emma F. Ekwok

Ella M Guest

Mandy Jones

Appendix B

Hydraulic Report

Included in this section:

1. Quinhagak Erosion Mitigation Planning Study: Preliminary Hydraulic Report

PRELIMINARY HYDRAULIC REPORT

QUINHAGAK EROSION MITIGATION PLANNING STUDY

Prepared for
CRW Engineering Group, LLC

Prepared by
Herrera Environmental Consultants, Inc.

Note:
Some pages in this document have been purposely skipped or blank pages inserted so that this document will copy correctly when duplexed.

PRELIMINARY HYDRAULIC REPORT

QUINHAGAK EROSION MITIGATION PLANNING STUDY

Prepared for
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Introduction

The community of Quinhagak in southwestern Alaska is threatened by riverine erosion along the reaches of the Kanektok River (the river) that runs through the community (Figure 1). Qanirtuuq Incorporated (Qanirtuuq), an Alaska Native Village Corporation located in Quinhagak, sought to attain a better understanding of the erosion dynamics along the Quinhagak reach of the river to aid in the design of permanent protection measures for the community.

CRW, Inc. (CRW) contracted with Herrera Environmental Consultants (Herrera) to support this effort. CRW provided survey and logistical support to evaluate flooding and erosion risks to the community. Key to this effort was the development of a two-dimensional hydraulic model that could assess the hydraulic and geomorphic impacts associated with potential actions to protect the community and direct the river's forces away from infrastructure.

Methods

Hydraulic and Geomorphic Assessment

The natural and anthropogenic forces that have shaped (and continue to shape) the Kanektok River are dynamic and complex. This assessment involved the review and analysis of existing data sources and information relevant to the project, as well as data collected in the field during site visits. Field data provided more site-specific information when compared with existing information sources, which were generally regional in scale.

Conditions at the project site were identified during a 2-day-long visit to the site on June 5 and 6, 2018. During the visit, the Kanektok River was in flood due to recent warm temperatures and snowmelt. The river was observed both from the air and via boat, extending from river mile 7 to its mouth in Kuskokwim Bay. River banks (typically the left bank) were observed, specifically, those in areas of overbank flooding, those indicative of past erosion, and those adjacent to the existing gravel pits. Adjacent beaches on Kuskokwim Bay at convenient access points were also observed.

In addition to the site visit and observations, several village members were interviewed to obtain historical and current site information.

Geomorphic Assessment

The geomorphic assessment relied heavily on documentation of the site characteristics and other literature describing the hydrology, hydraulics, history and geology of the greater Quinhagak area. This included the assessment of existing literature, as well as the data obtained during the site visit. The literature and data reviewed included:

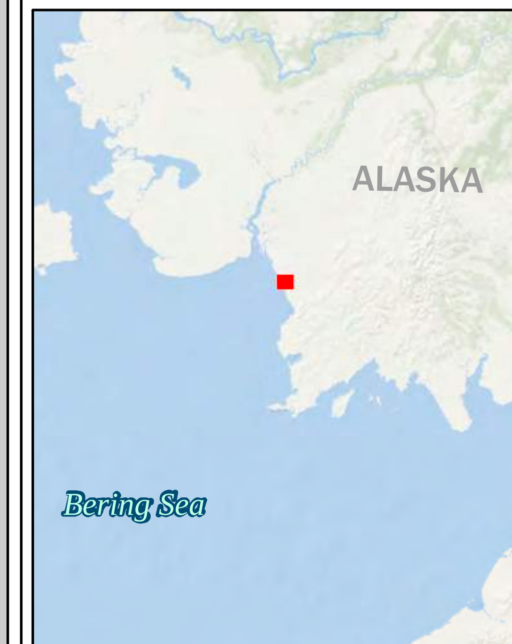
- Historical aerial photographs taken in 2003, 2007 and 2011 (Google 2018: Appendix A)
- Historical aerial photographs taken in 1952, 1964, 1972, and 1982 available from the University of Washington library (Appendix A)
- Historical topographic map from 1954 available from the USGS (USGS 1954: Appendix A)
- A geologic map of the area (Hoare and Coonrad 1978)
- A series of documents prepared to mitigate hazards and improve infrastructure in the Quinhagak community (USACE 2010, City of Quinhagak Mitigation Planning Team 2012, Powtec, LLC 2013)
- A summary of village elder knowledge about the community (Rearden and Fienup-Riordan 2013)
- A recent characterization of the river and its basin (Bureau of Land Management 2012)
- LiDAR data collected by the National Geospatial-Intelligence Agency (Intermap 2015)

Hydraulic Modeling

The software used to perform the hydraulic modeling for this project is RiverFlow2D Version 6.02.03. RiverFlow2D is a hydrodynamic and mobile-bed model specifically developed for rivers. It is a two-dimensional, finite-element model for routing flood flows that enables high-resolution flood hydraulic analysis. A flexible triangular mesh refines the flow field around key features of interest in complex river and stream environments. RiverFlow2D uses the shallow-water equations for depth-averaged, free-surface flow that allow simulation of water surface elevations and two components of the flow velocity, resulting in resolution of detailed two-dimensional channel hydraulics and overbank flooding characteristics.

The hydrologic inputs for the model were determined from USGS published regression equations for estimating peak streamflows for unregulated streams in Alaska (Curran et al. 2003). Regression equation inputs were determined from a GIS-based analysis of the watershed. The downstream boundary condition is set from tidal heights in Kuskokwim Bay using a recent tidal series with a peak at mean higher high water (NOAA 2018a).

Figure 1.
Vicinity Map for the Quinhagak Erosion Mitigation Planning Study, Quinhagak, Alaska.



0 1,100 2,200 4,400
Feet

Digital Globe, Aerial (2015)

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Another input to the hydraulic model is roughness, characterized by a Manning's n value. The model used n values of 0.03 for areas in the river channel itself, 0.08 for floodplain areas, and 0.08 for bank protection (riprap/rock and super sacks). The model was run for 25 hours with a peak building to the peak flow, simultaneously occurring during an average high tide.

Topographic Survey

Topography analyzed in the analysis herein was integrated from LiDAR data (Intermap 2015) and a site survey performed by CRW. The site survey focused on bathymetry in the river. It tied both the LiDAR data and site survey data to a CRW-developed, Quinhagak-specific projection. For more details about survey data collection, please refer to an upcoming report from CRW.

Alternatives Analysis

Alternatives to be analyzed were developed in consultation with CRW and the Quinhagak community. Details of the river reroute were determined based upon professional experience with other reroute projects. Locations of the bank protection were selected based upon site observations of erosion, input from CRW, and Qanirtuuq staff.

RESULTS AND DISCUSSION

Hydraulic and Geomorphic Assessment

The Kanektok River drains 911 square miles of the Ahklun Mountains in southwestern Alaska. Its headwaters are Pegati Lake and it flows 94 miles to where it empties into Kuskokwim Bay near the village of Quinhagak (Bureau of Land Management 2012). The basin is predominantly treeless tundra with some modest forest in the mountains. The river is unregulated and unarmored outside of Quinhagak.

Geomorphic Assessment

In order to accurately predict future geomorphic changes, it is helpful to understand how the river has migrated in the past. At the longest time scales, based upon the spatial pattern of alluvium and tundra, the Kanektok River likely prior discharged to the north via a separate route several times since the modern glacial terrace was deposited at least 10,000 years ago. This is corroborated by the name Quinhagak, which means "new channel" in Yupik (Reardan and Roirdan). It is unclear which path the river took prior to its current course, but it is most likely that Oyak Creek was the outlet prior to the most recent relocation, but several other creeks (e.g., Warehouse Creek) have conveyed the Kanektok River in the recent geologic past.

Migration has also been a continuous process in the current alignment of the river. One key piece of evidence for this is the prophecy from the village elders that “the village will have to be moved five times until it finds its ultimate location” (Rearden and Fienup-Riordan 2013). From the earliest aerial photographs, at the time of statehood, the village was oriented north-south along a former beach ridge, which is now called “Old Town.” This peninsula caused an extreme meander in the lower Kanektok, as seen in the aerial photographs in 1972 and prior (Appendix A). However, at some point between 1972 and 1982, the spit’s northern end was cut through by the river. It has since left only a nub of the former peninsula, which continues to erode (see cover photograph). During the period where the peninsula was cut through, the AVCP built new homes between Old Town and the (former) airport. This area was higher ground and serves as the current location of the community. However, as noted by village elders (Rearden and Fienup-Riordan 2013), there were occurrences during the late twentieth century where the river eroded the higher terrace and damaged or destroyed structures near its edge.

Areas upstream were equally dynamic during this time period. The river avulsed and abandoned a high amplitude meander near the former airport. This remains a side channel, which will hereafter be called the 1950s channel, as it was the active channel during this time. This channel has unusual characteristics, as it does not freeze, indicative of a significant hyporheic input and potentially high habitat quality for anadromous fish. As can be seen in the 1982 aerial (Appendix A), there is a side channel forming in the current location of the main channel. Also, in this area there appears to be an area of disturbance (likely a gravel pit). From interviews, it was this pit that initiated the avulsion that is now eroding the former airport. This has left two meanders that are migrating south, towards former river channels, at the east end of the village. These particular erosion areas will be addressed separately below, along with several other areas of concern.

End of Former Runway

The end of the former runway is the most pressing erosion concern. As can be seen in Figure 2, excavation has occurred next to a rapidly eroding bank. Removed fill should be replaced immediately to prevent occupation of the river south of the former runway. Occupation of these areas will not only compromise the road and access, but it could enable the river to flow close to existing buildings, like the new school. Fill materials do not necessarily need to be composed of sand gravel but should be placed at least to the elevation of eroding bank in Figure 2. Even with replacement of fill, the bank will erode; and protection is recommended (though not urgent once the bank material is replaced).

Former Airport

The former airport was the principal concern of the community. It is the location where past erosion has placed access to gravel at the greatest risk. Erosion in this location started to become a problem when a former gravel pit was captured by the river near the former runway sometime in the 1990s. This has been a site of past super sack deployments. According to most interviewees and onsite observations, these treatments were only temporarily effective.

Figure 2. Looking Downstream at the End of the Former Runway, Quinhagak, Alaska.

Because of the lack of vegetation, loose alluvium substrate and the high velocities in this area, future erosion in this location is expected. It is likely that the access road will be lost in a relatively short period of time (a few years or less). Like at the end of the former runway, the biggest concern is that the river will access low ground south of the old runway and develop a new channel closer to the community. Although this is not an imminent risk to the community (aside from the loss of access to gravel sources), it does present a significant long-term risk to the community and should be addressed.

Water Supply Road

On June 5, flow over the water supply road was observed (Figure 3). Overtopping is also seen in the model beginning in the 2-year event. Since this is a relatively frequent occurrence, there is a concern of an avulsion in this location. Modeling indicates flow velocities are modest, generally less than 4 feet per second, which is consistent with onsite observations. Currently water flow is constrained by patchy, dense vegetation. Since the path length over which overbank water flow is comparable to the main channel length in this area, it means the probability of avulsion is modest, though overtopping may continue to occur and compromise access to the water supply intake over time.

Figure 3. Flow Over the Water Supply Road on June 5, 2018, in Quinhagak, Alaska.

Port and River Mouth

The river mouth has aggraded, primarily with gravel and sand, and confined flow to the right bank, limiting the ability of vessels to access the port on the left bank (Figure 4). Although it is likely that there has been a bar at the mouth of the river throughout the history of the Kanektok River being in this location, consensus in the community is that this situation has worsened recently. This is understandable and consistent with a series of contributing factors. They are:

- **Sea level rise:** It is well known that rising sea level will cause deposition of river mouths. Sea level rise has been more pronounced in the Bering Sea than other places, with as much as 15 centimeters (0.5 foot) seen at Port Moller since 2000 (NOAA 2018b). Although modest, this could change the dynamics of sediment transport in the estuary and trigger deposition that formerly occurred on the continental shelf to occur in the river itself.

- **Increased erosion rate of adjacent marine shorelines:** Sea level rise, increased storminess (i.e., heightened waves), loss/melting of permafrost, and reduction in Bering Sea ice cover all combine to contribute to coastal erosion in western Alaska. These contributing factors to coastal erosion are well documented in the scientific literature. Unfortunately, at Quinhagak, this process has increased littoral transport and increased bar formation at the river mouth.

- **Increased sediment supply from upstream migration and avulsion:** Also possibly contributing to these other problems, sediment supply from the Kanektok River itself may have increased locally in recent years. Recent avulsion and channel migration produce more sediment near the community than under predevelopment conditions. Sediment production is increased in areas that have been denuded of vegetation, which are common along several of the eroding banks. Some of the increase is manmade. While it is unlikely that this alone could explain the sediment bar at the river mouth, this effect could have contributed to the existing problems mentioned previously.

These interrelated processes are mostly beyond the community's control. The only process that can be reasonably altered is the production of local sediment from bank erosion and avulsion. Where possible, actions should be taken to reduce bank erosion and channel migration further upstream. These processes are already impacting other Alaska coastal communities and there might be funding resources that could be identified to assist with addressing them.

Figure 4. Eroding Banks on the Right Bank at the Mouth of the Kanektok River.

Gravel Pits

Another area of interest was the gravel pits. Aerial photographs indicate that former gravel pits have caused avulsions in the past, which was also corroborated by several village members testimony. Therefore, there is reasonable concern that the existing gravel pits could be captured in the future. Further, there is a small side channel that meanders near the gravel pits and could accept water from much further upstream. However, on the site visit, when the river was flooding, it was found that flow was directed away from the side channel inlet, indicating that it is a dwindling feature. Nearer to the pits, the overbank flow must pass through thick vegetation to reach the pits, which also slows flow and diminishes the risk of capture. Similar effects were seen in the model. Despite the apparent risk, if no further excavation encroaches on the river, capture of the pits appears to be a low probability event given the current alignment of the river.

Existing Conditions Hydraulic Modeling and Flooding

Hydrology

The USGS published regression equations for unregulated streams in Alaska were used to determine the 2-year and 100-year recurrence interval peak streamflow values. The project area falls within Region 6. Regression equation inputs included drainage area (911 square miles), area of lakes and ponds (3.5 percent), and area of forest (4.3 percent), which were determined from a GIS-based analysis of the watershed. From this analysis the 2-year recurrence interval peak streamflow value was determined to be 9,400 cubic feet per second (cfs), and the 100-year value was determined to be 21,200 cfs. These streamflow values were used in the hydraulic modeling analysis.

Hydraulic Model Results

Figures 5 through 7 illustrate the relevant model results to assessing erosion risks. Emphasis is on the 2-year event since this has been shown to be the smallest, but most frequent, event capable of producing erosion and geomorphic change. Inundation shown in Figure 5 was used to compare to (aerial) observations made during the site visit. Modeled 2-year velocities (Figure 6) are consistent with a 2-year event being capable of producing geomorphic change. The velocities seen in Figure 6 should be sufficient to mobilize most of the bed material in the river.

Finally, as can be seen in Figure 7, nearly all of the village remains dry in the 100-year event, indicating that flooding is not a problem with the exception of a few homes near the river or active side channels. Also, there does not seem to be a pathway for flow to encroach on the community during a large flood event.

Topographic Survey

Topographic survey, primarily bathymetry, was obtained the week of June 5, 2018. The bathymetric surface was stitched by CRW with the LiDAR product produced by Intermap (2015) to form a continuous surface throughout the study area. The surface was also used for developing and determining quantities for the alternatives.

Alternatives Analysis

The objective of the alternatives development process was to select combinations of options that would reduce hydraulic and geomorphic risk to the community. The alternatives developed and analyzed as part of the project can be broken into two categories, those that attempt to relocate the river away from critical infrastructure (Channel Reroute Alternatives) and those that protect infrastructure by attempting to lock the river alignment in place using bank protection (Bank Protection Alternatives), which can be seen in Figure 8.

- **Alternative 1:** This alternative is the most obvious and commonly suggested river reroute by the community. It requires excavation of a small ridge of high ground to connect the main stem to what we refer to as the 1950s channel. It also requires some excavation of each channel past the connection points to make it positively draining. This alternative widened the channel through the ridge and in the main channel and placed a berm to restrict return flow back to the main channel to improve the performance of the alternative. The alternative is in a single native allotment.

- **Alternative 2:** This alternative sought a more direct route to connect the main channel to the 1950s channel further away from the community. The intent was it has a steeper gradient and reduced impact to the community because of its distance from existing development. It was made 35 feet wide to conform to the natural width of connecting channels. The alternative is in a single native allotment.

- **Alternative 3:** Alternative 3 is similar to Alternative 1, but it connects downstream of the end of the former runway and closer to the former airport. It is short, and unlike Alternative 1, does not require additional channel excavation to positively drain. It was made 40 feet wide. Unlike Alternatives 1 and 2, it is the only reroute not on private land.

- **Alternative 4:** Alternative 4 sought to completely address erosion risks through bank protection. It assumes rock (riprap) placed the entire height of the bank at a 2H:1V slope into the river for 1,500 feet at the former airport and 300 feet at the end of the former runway.

- **Alternative 5:** Alternative 5 is a scaled-down version of Alternative 4, assumed to use only 900 feet of super sacks. Super sacks are not as effective because they breach and bleed out their contents over time. However, they can provide a less-expensive, effective short-term solution to acute erosion problem. The length was obtained by estimating the most vulnerable 900 feet of bank.

- **Alternative 6:** Alternative 6 combines Alternative 1 and Alternative 4.

The results of the alternatives analysis conducted for the project are presented in the following section, including an assessment of the potential impacts associated with each.

Figure 5.
Water Depth in the 2-Year Event, Kanektok River, Alaska.

Legend

Depth (ft)

< 0.5
0.51 to 1
1.1 to 1.5
1.6 to 2
2.1 to 2.5
2.6 to 3
3.1 to 3.5
3.6 to 4
4.1 to 6
6.1 to 8
8.1 to 10
>10

N

0 1,100 2,200 4,400 Feet

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Digital Globe, Aerial (2015)

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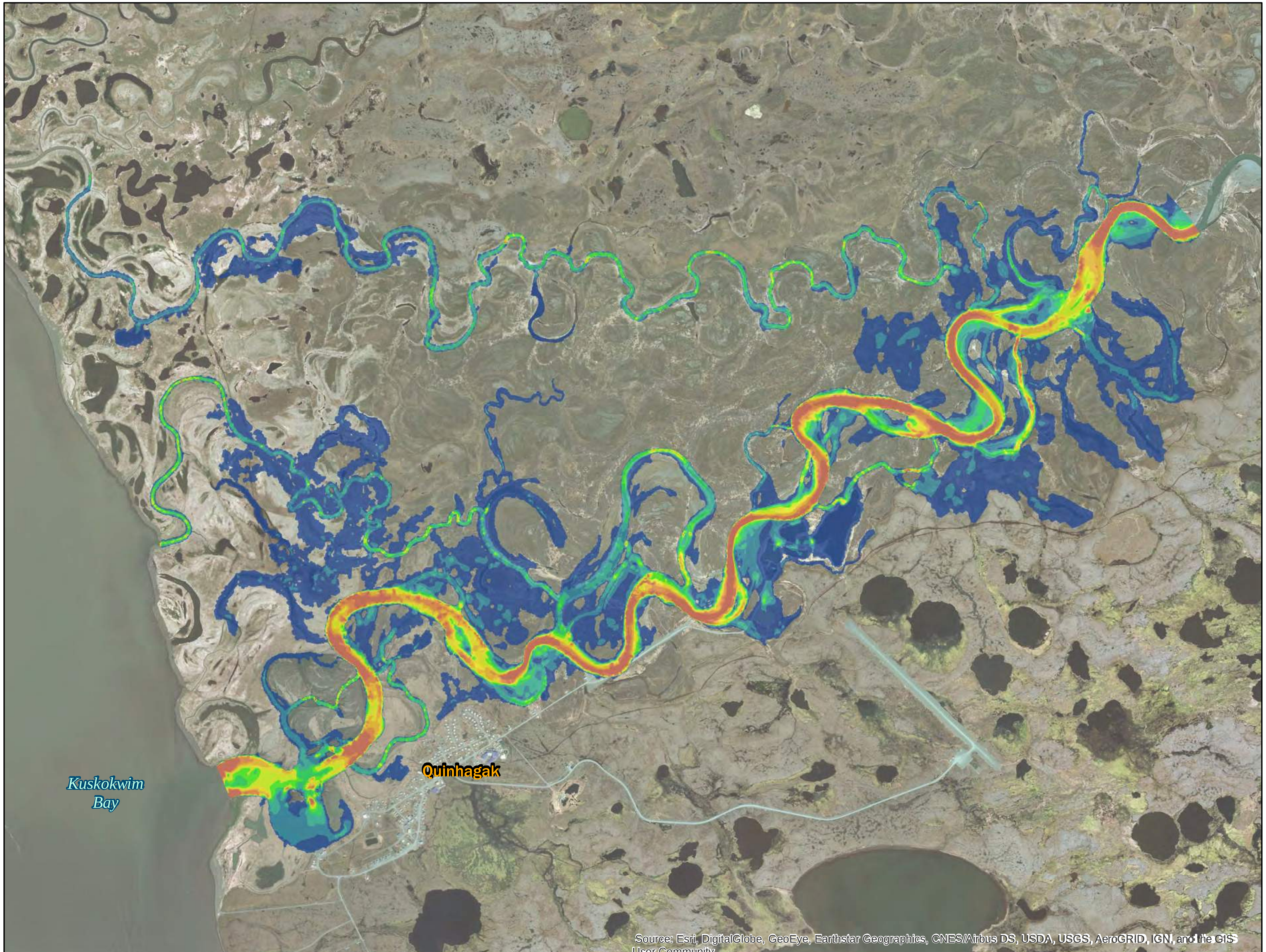
Figure 6.
Water Velocity in the 2-Year Event, Kanektok River, Alaska.



Legend

Velocity (ft/s)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 4.5
- > 5

N

0 1,100 2,200 4,400 Feet

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Digital Globe, Aerial (2015)

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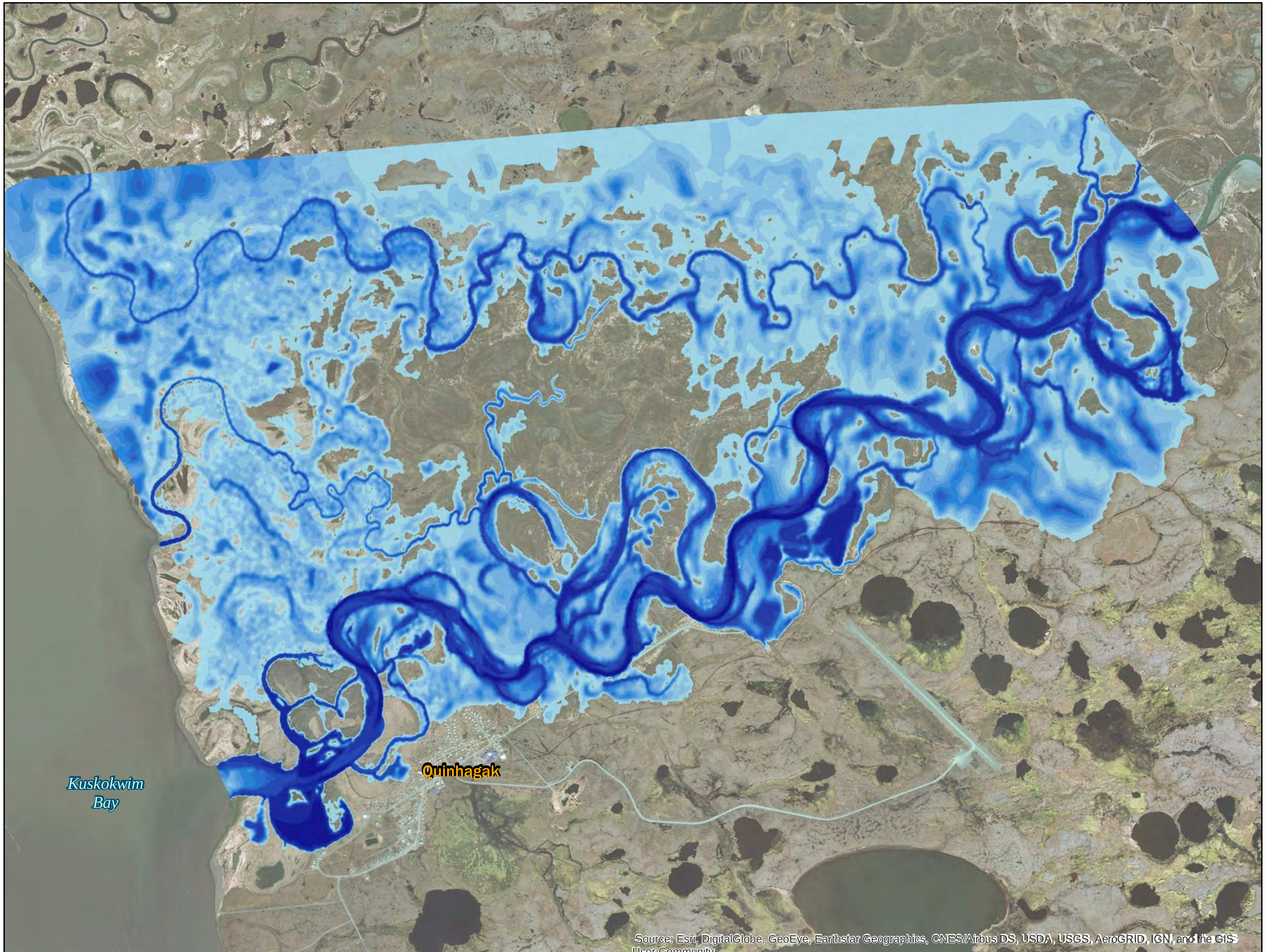
Figure 7.
Water Depth in the 100-Year Event, Kanektok River, Alaska.



Legend

Depth (ft)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 6
- 6.1 to 8
- 8.1 to 10
- >10

N

0 1,100 2,200 4,400 Feet

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Digital Globe, Aerial (2015)

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Figure 8.
Channel Reroute Alternatives and Bank Protection Alternatives.

Legend

- Bank protection alternative
- River re-route alternative

N

0 750 1,500 3,000 Feet

HERRERA

Digital Globe, Aerial (2015)

Channel Reroute Alternatives

Alternative 1

The 2-year velocity results shown in Figure 9 demonstrate the effectiveness of this alternative. As can be seen in the figure, the velocity in the excavated portion of the diversion channel, as well as the remainder of the 1950s channel, indicate that the diversion of flow will likely be maintained and possibly might widen over time. It can also be seen that the velocity in both bends subject to erosion are lowered significantly, though the effects are much more pronounced near the end of the former runway. The lowered velocities will likely and may eventually cause abandonment of the main channel between where the channel has been diverted and the downstream end of the 1950s channel. Especially promising is the lack of change downstream of 1950s channel and main channel confluence. This lack of change in velocities suggests that downstream impacts will be minimal, particularly at first. However, the large velocities in the diversion channel and the 1950s channel may produce large volumes of sediment as flow concentrates there, which may influence downstream areas over time.

Alternative 2

Although Alternative 2 has a steeper gradient that Alternative 1, it proved to be much less effective at diverting flow. It did not alter velocities in either the 1950s channel or the main channel. Therefore, it will likely not be sustainable (i.e., the diversion channel will fill over time) and will not prevent bank erosion in the main channel.

Alternative 3

Like Alternative 2, Alternative 3 also did not effectively divert flow from the main channel to the 1950s channel. As a result, there was very little change to flow in the main channel or the 1950s channel. Therefore, like Alternative 2, the Alternative 3 diversion channel is likely not to be sustainable in the long term or prevent bank erosion in the main channel.

Bank Protection Alternatives

Alternative 4

Modeling of Alternative 4 indicates that there is little offsite risk associated with rock placement along eroding banks. It is likely that the relative width of the footprint of rock as compared to the river is negligible. Local erosion may occur at the downstream end of the rock, but this should remain a local effect, particularly in the short term.

Alternative 5

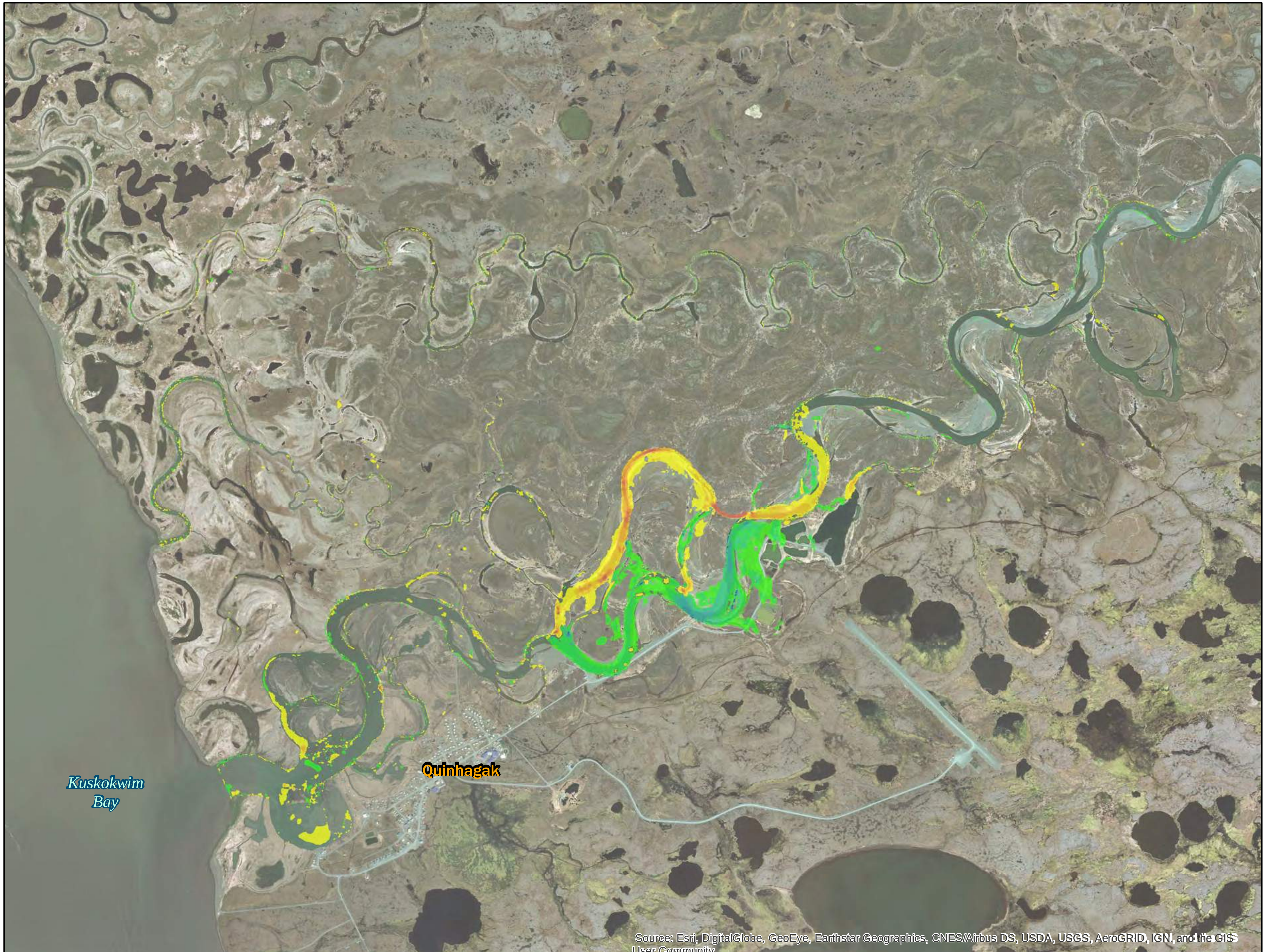
Since Alternative 5 is a scaled-down version of Alternative 4, impacts are even less with this alternative than compared to Alternative 4. Therefore, it is expected that only erosion at the downstream end of the armoring will occur with this alternative. This effect will also be modest.

Alternative 6 (recommended long-term action)

Alternative 6 reduces risk to the community from both bank erosion and channel migration and avulsion by diverting flow away from the vulnerable northeast end of the village. This alternative has virtually the same flow patterns as Alternative 1 shown in Figure 9. From the modeling, in the short term, it produces no detrimental hydraulic or geomorphic impacts. In the long term, it is expected that the river will migrate away from the northeast edge of the village such that there is no longer an erosion risk to the community. Because it combines bank protection with channel diversion it reduces both short-term and long-term risks to the community.

To implement this alternative, it will likely be necessary deepen marine access to the project site. Although USACE (2010) was pessimistic about the options it considered to enhance access to the port, a dredge may provide some short-term relief to access to the port, while local sediment supply could then be reduced due to bank armoring. The combination of these project actions should not only protect the village from erosion, but hopefully also improve (though not eliminate) deposition problems at the port.

Figure 9.
Water Velocity DIfference in the 2-Year Event for Alternative 1 as Compared to Existing Conditions, Kanektok River, Alaska.



Legend

Velocity difference (ft/s)

- <-3
- -2.9 to -2.5
- -2.4 to -2
- -1.9 to -1.5
- -1.4 to -1
- -0.9 to -0.5
- -0.49 to -0.25
- -0.24 to 0.25 (no color)
- 0.26 to 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- > 3

0 1,100 2,200 4,400 Feet

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Digital Globe, Aerial (2015)

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Conclusions and Recommendations

The Kanektok River places the community of Quinhagak at risk to erosion and ultimately inundation. The risk is not immediate unless other channels further south are engaged, and the higher glacial terrace is undermined by erosion. However, given the dynamic and unregulated nature of the river, this could conceivably happen in a relatively short amount of time (i.e., years) if erosion were to continue unabated. Of particular concern is the end of the runway. Excavated fill removed recently should be replaced immediately.

The modeling of the alternatives, particularly Alternative 1, also indicates something about the potential future migration of the Kanektok River. The narrow strip of land separating the main channel from the 1950s channel is actively eroding, albeit at a slower rate than at the former airport. The modeling indicates that if this strip of land were removed, even if by natural processes, the river will migrate away from its current alignment between the end of the runway and just upstream of the water supply. This would likely result in a situation similar to the implementation of Alternative 1. Therefore, a temporary solution might be possible to bridge the time until this occurs; however, it is unlikely that Alternative 5 would last sufficiently for natural diversion to occur.

Therefore, the most prudent approach would be to implement Alternative 6. The main barrier to implementation, other than access to equipment due to deposition near the port, is cost. It is the most expensive of the considered alternatives. However, the alternative could easily be phased. Bank protection should be implemented first, with the possible short-term protection of Alternative 5 maintaining the bank until more robust rock could be imported to the site. Following securing the bank, the diversion channel could then be constructed, diverting the river away from the vulnerable northeast end of the village.

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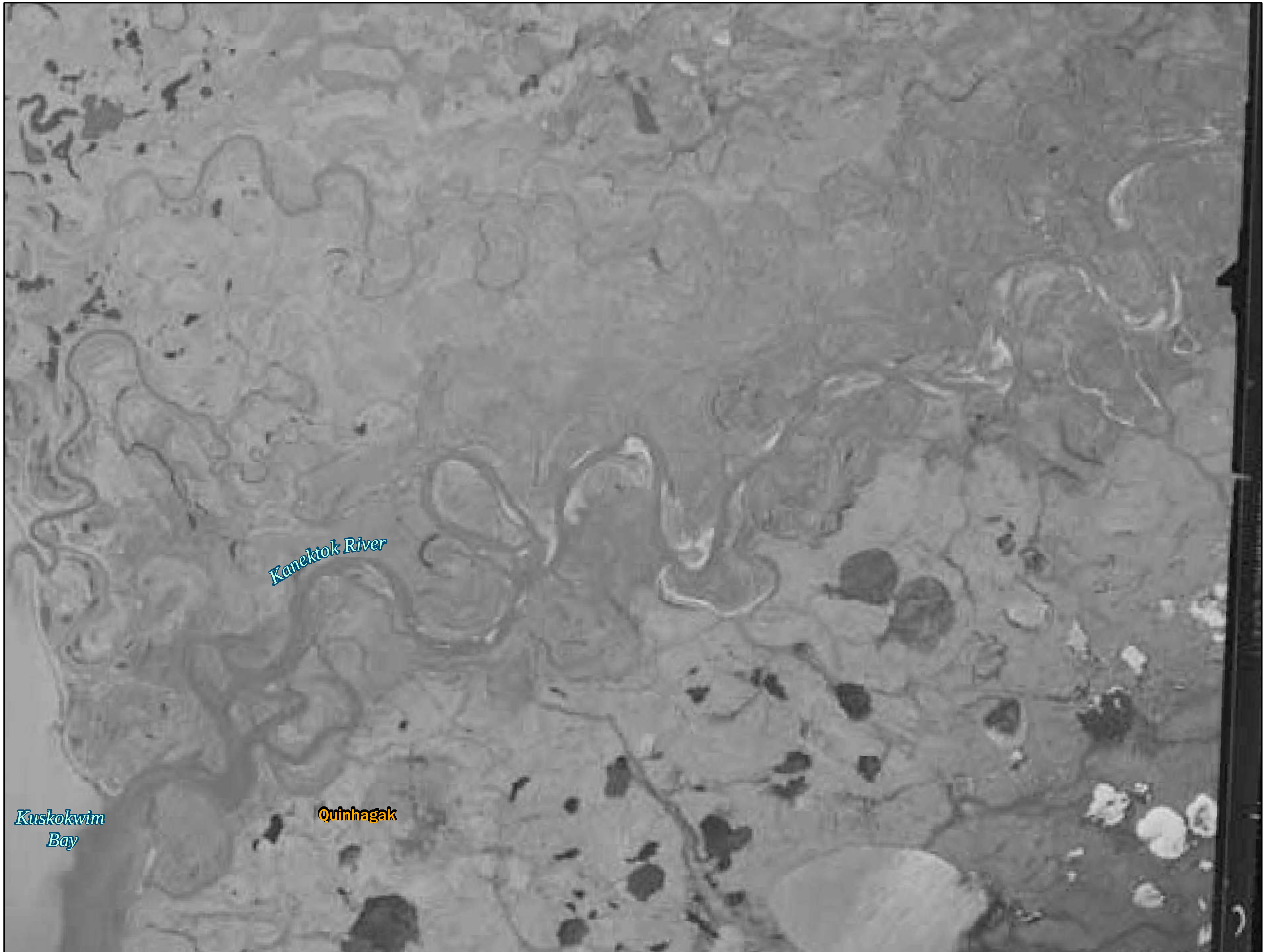
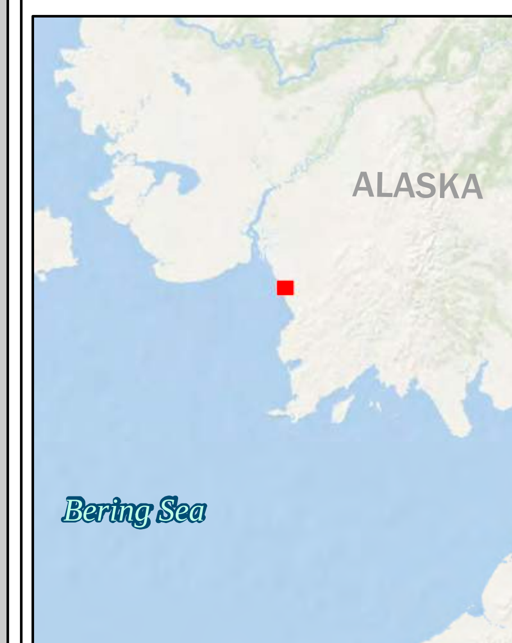
APPENDIX A

Historical Maps and Aerial Photographs

Aerial Overview 1952
Kanektok River, Quinhagak, Alaska





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NAD 1983 StatePlane Alaska 7 FIPS 5007 (Feet)
Source: ESRI, Aerial

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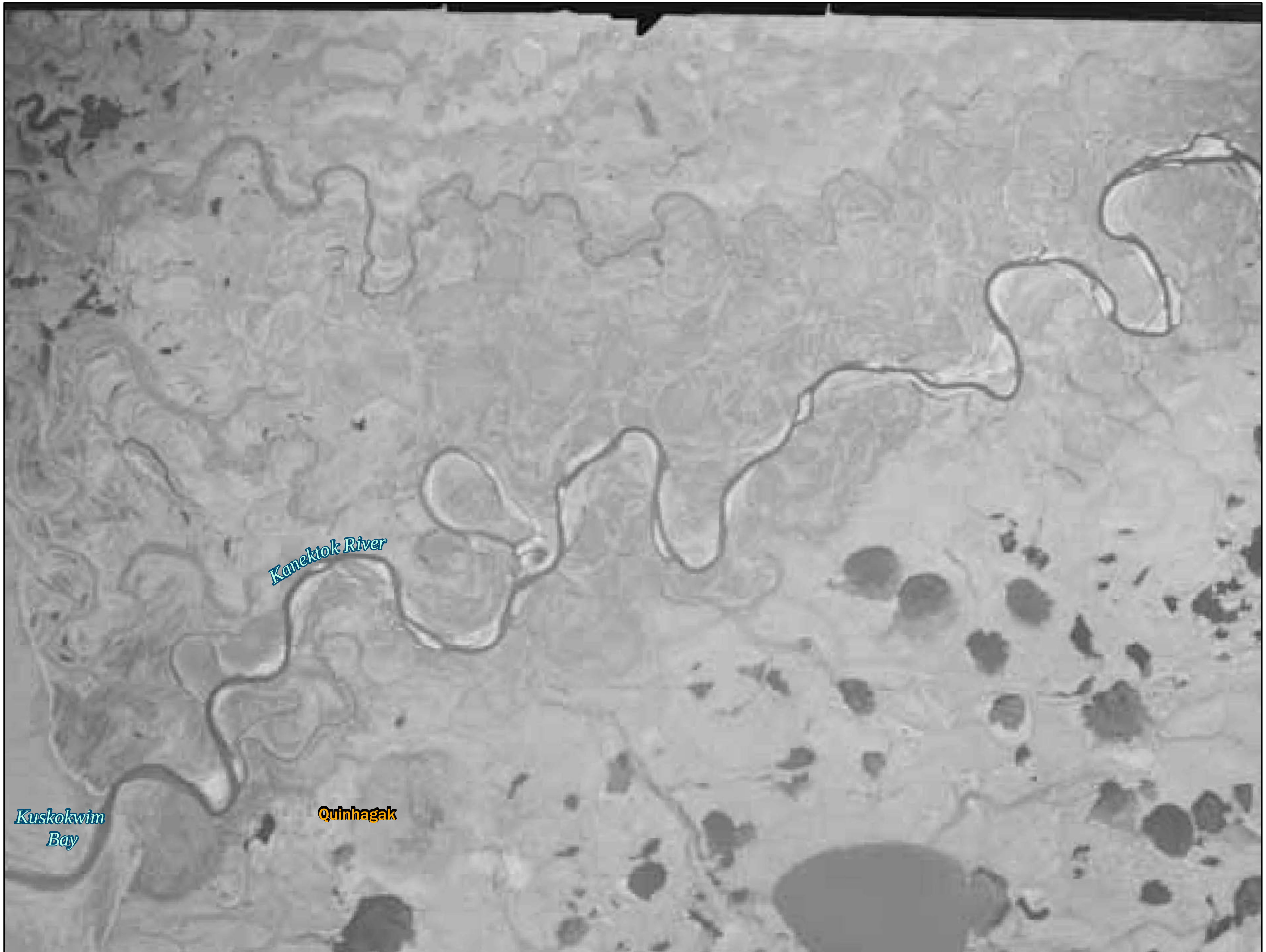
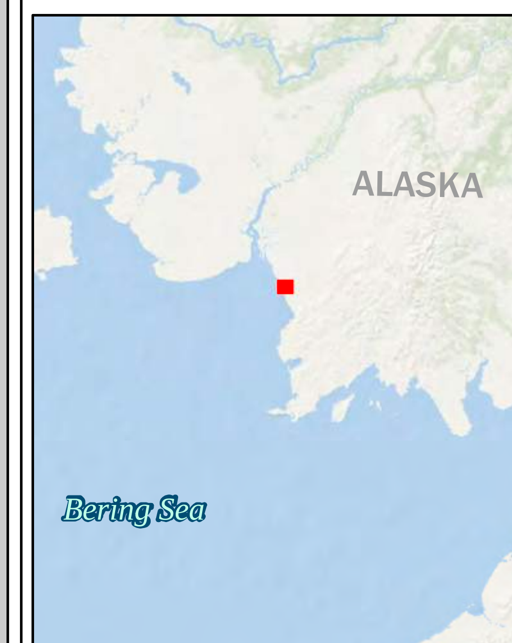
Aerial Overview 1954
Kanektok River, Quinhagak, Alaska





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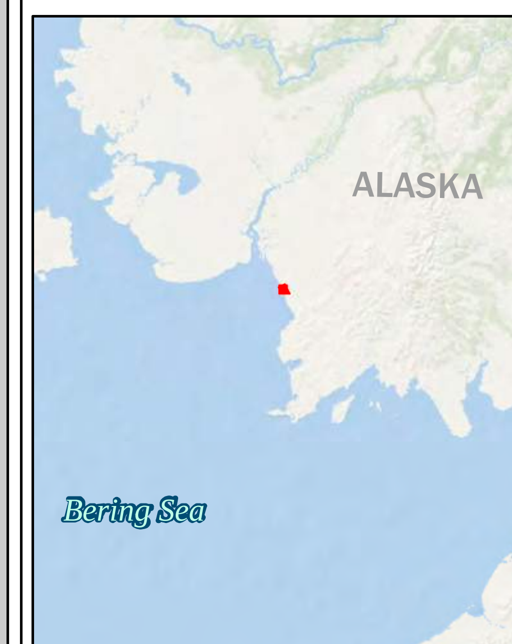
Feet

HERRERA

NAD 1983 StatePlane Alaska 7 FIPS 5007 (Feet)
Source: ESRI, Aerial

K:\Projects\Y2018\18-06770-000\Project\GISWorking\Historical_Aerials\Quinhagak_aerial_1954.mxd

Aerial Overview 1964
Kanektok River, Quinhagak, Alaska



N

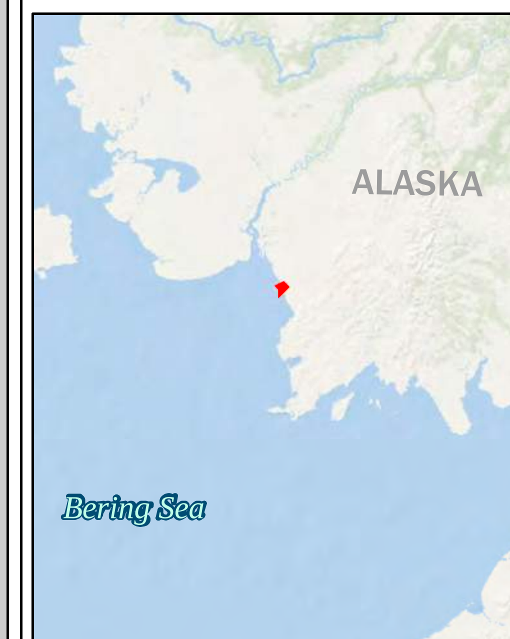
0 150 300 600
Feet

HERRERA

NAD 1983 StatePlane Alaska 7 FIPS 5007 (Feet)
Source: ESRI, Aerial

K:\Projects\Y2018\18-06770-000\Project\GISWorking\Historical_Aerials\Quinhagak_aerial_1964.mxd

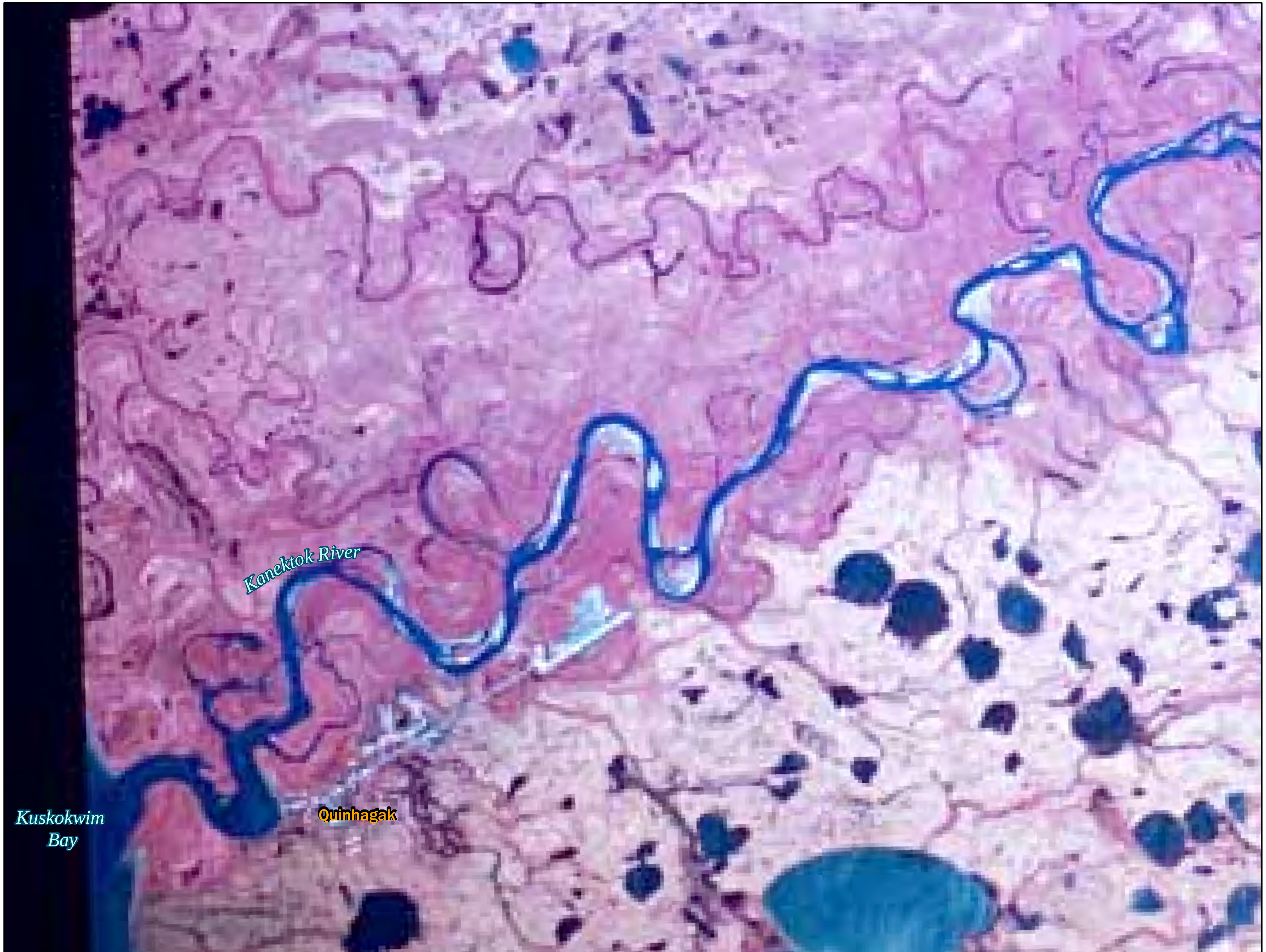
Aerial Overview 1972
Kanektok River, Quinhagak, Alaska

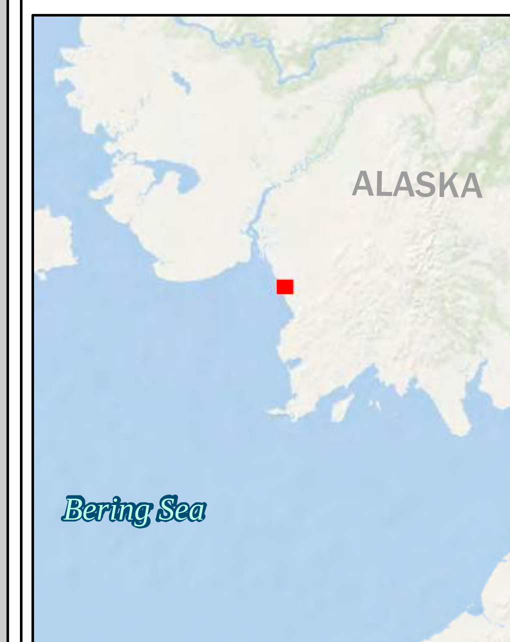


0 200 400 800
Feet

NAD 1983 StatePlane Alaska 7 FIPS 5007 (Feet)
Source: ESRI, Aerial

Aerial Overview 1982
Kanektok River, Quinhagak, Alaska





N

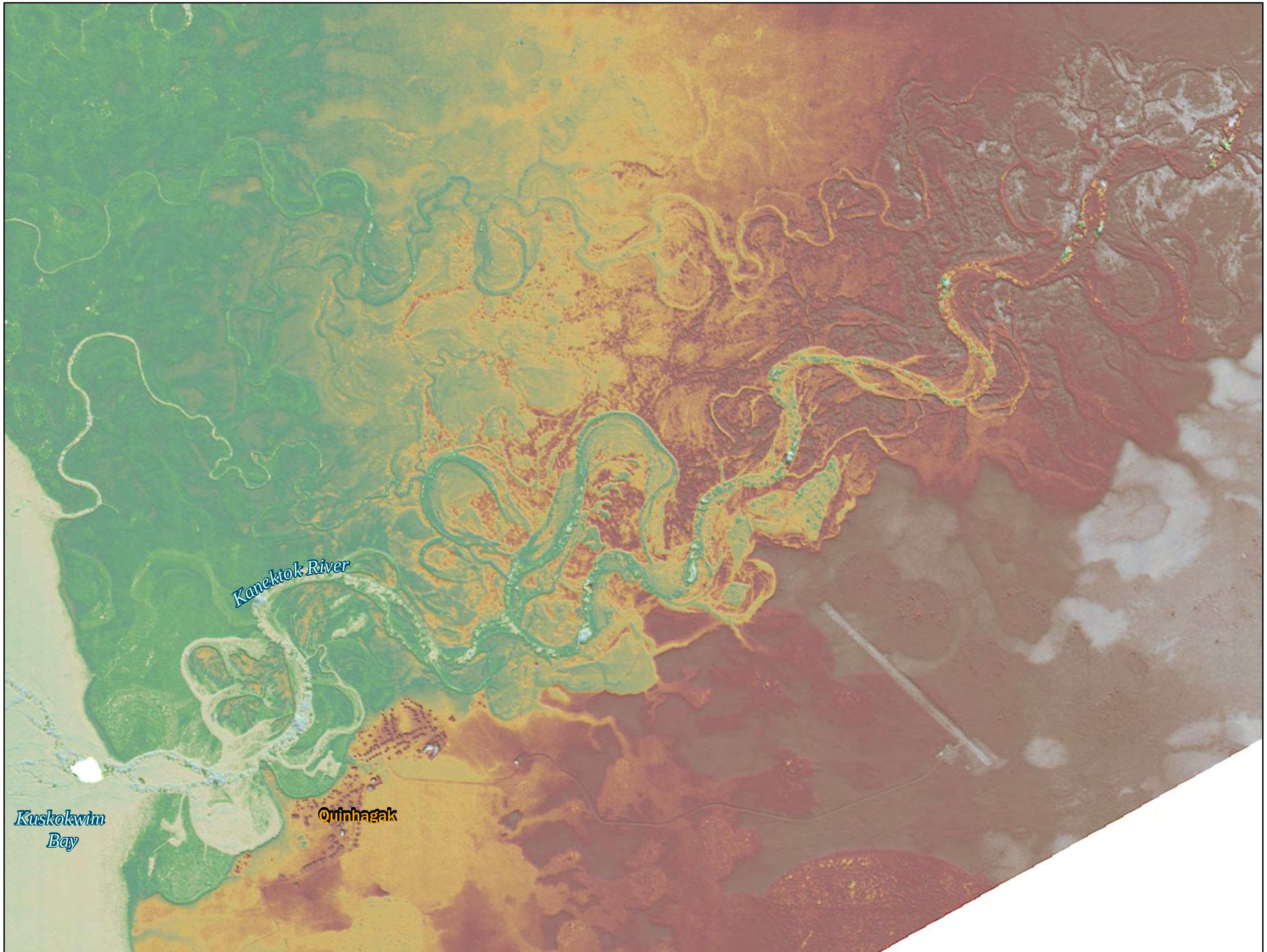
0 1,000 2,000 4,000 Feet

HERRERA

NAD 1983 StatePlane Alaska 7 FIPS 5007 (Feet)
Source: ESRI, Aerial

K:\Projects\Y2018\18-06770-000\Project\GISWorking\Historical_Aerials\Quinhagak_aerial_1982.mxd

LiDAR Overview (1 of 6)
Kanektok River, Quinhagak, Alaska



Legend

Elevation (ft)

41

0

N

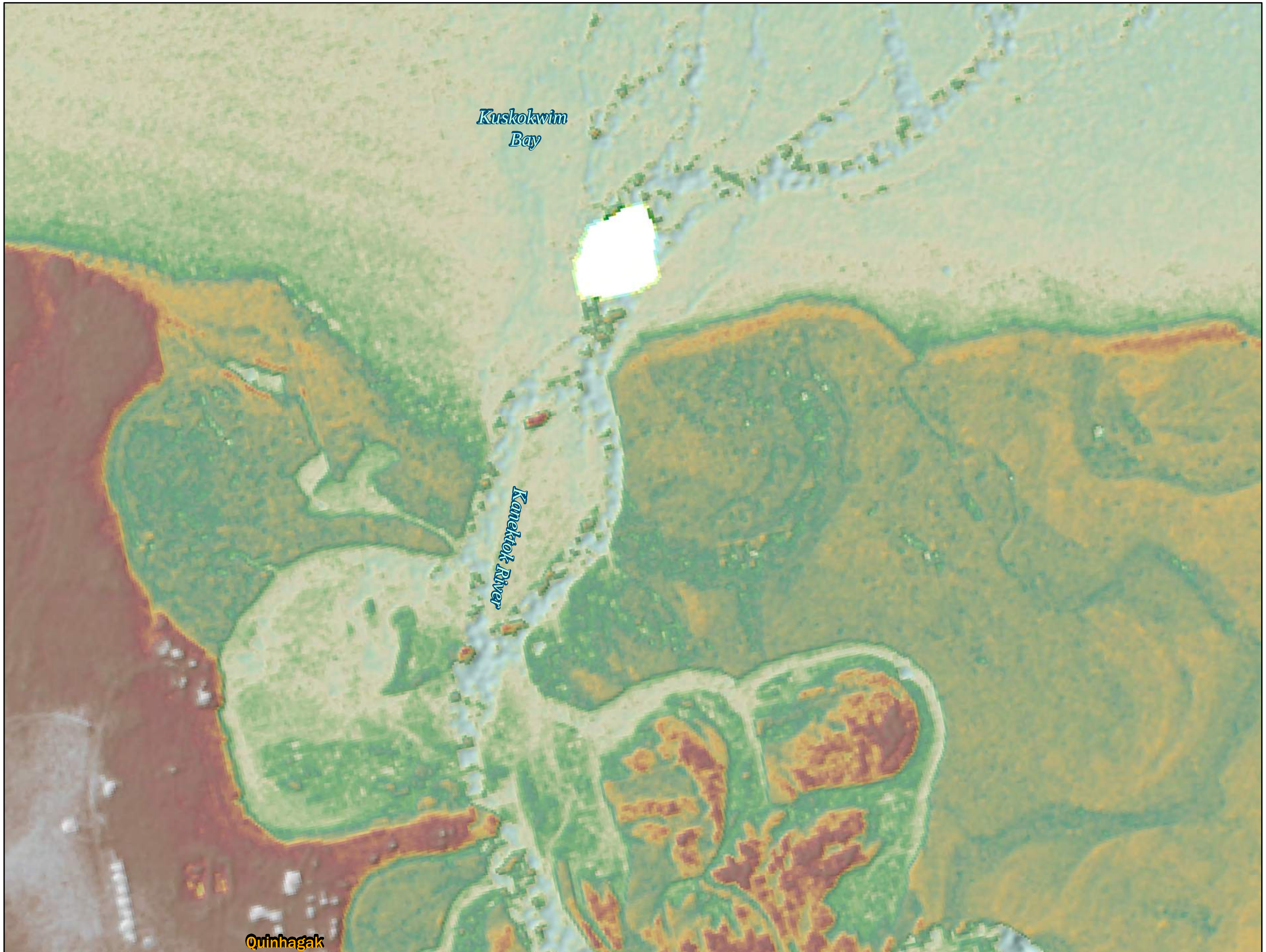
0 1,000 2,000 4,000
Feet

HERRERA

NAD 1983 StatePlane Alaska 7 FIPS 5007 (Feet)
Source: Polar Geospatial Center - U. of Minnesota

K:\Projects\Y2018\18-06770-000\Project\GISWorking\Quinhagak_lidar_overview.mxd

LiDAR (2 of 6)
Kanektok River, Quinhagak, Alaska

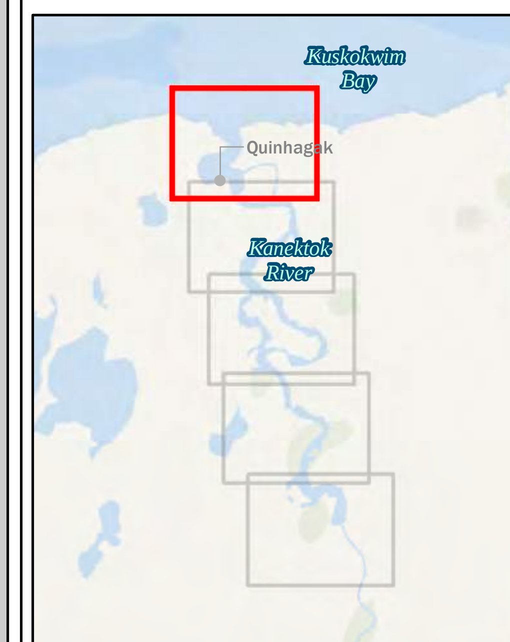


Legend

Elevation (ft)

24

14

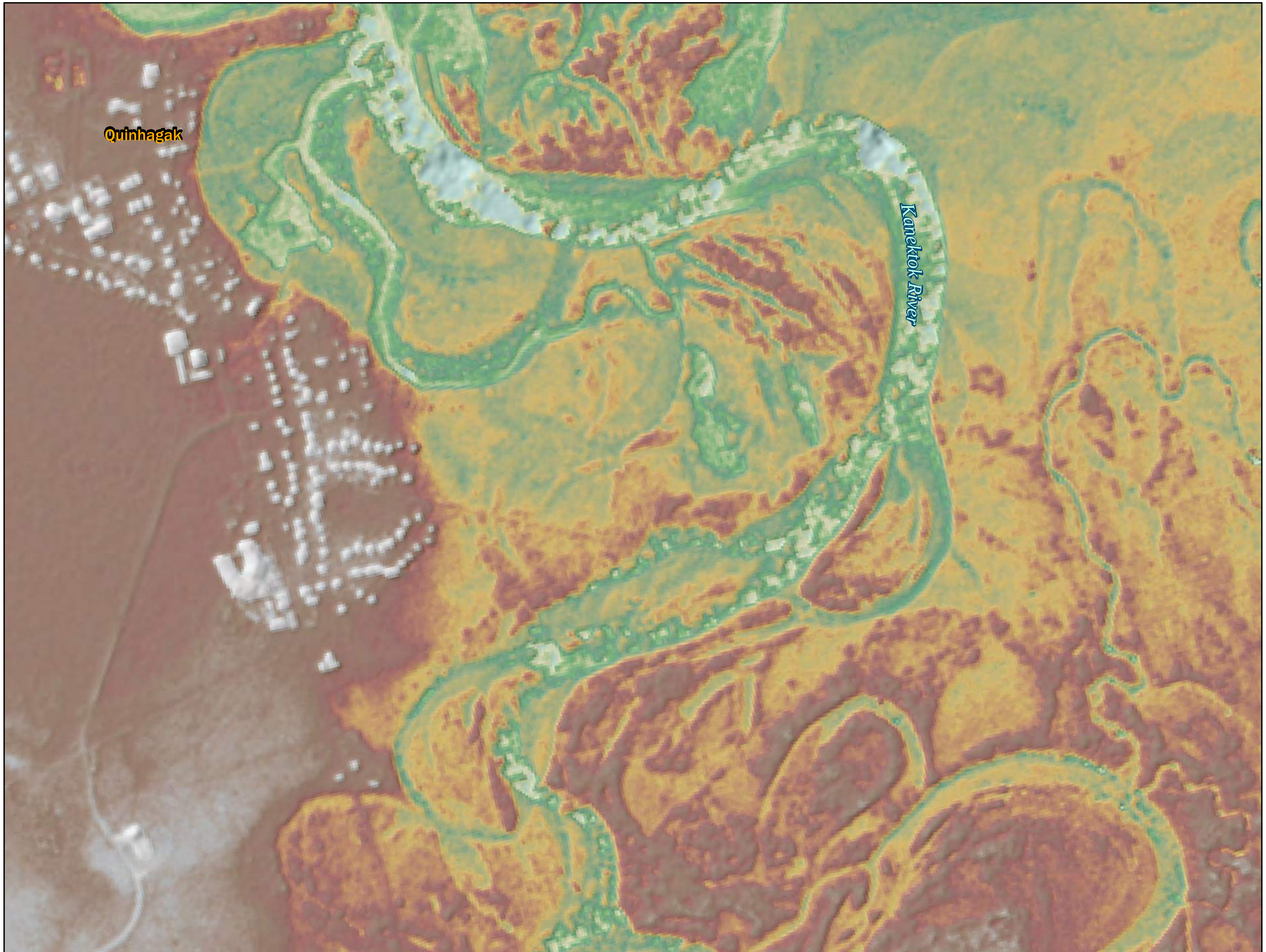


0 300 600 1,200 Feet

HERRERA

NAD 1983 StatePlane Alaska 7 FIPS 5007 (Feet)
Source: Polar Geospatial Center - U. of Minnesota

K:\Projects\Y2018\18-06770-000\Project\GISWorking\Quinhagak_lidar.mxd



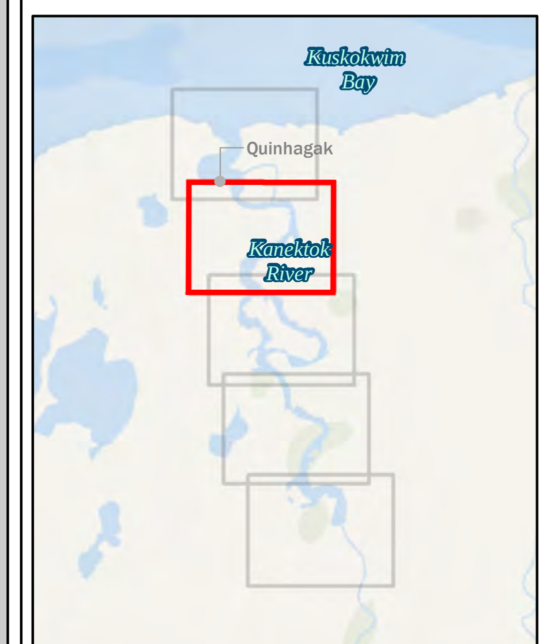
LiDAR (3 of 6)
Kanektok River, Quinhagak, Alaska

Legend

Elevation (ft)

24

14



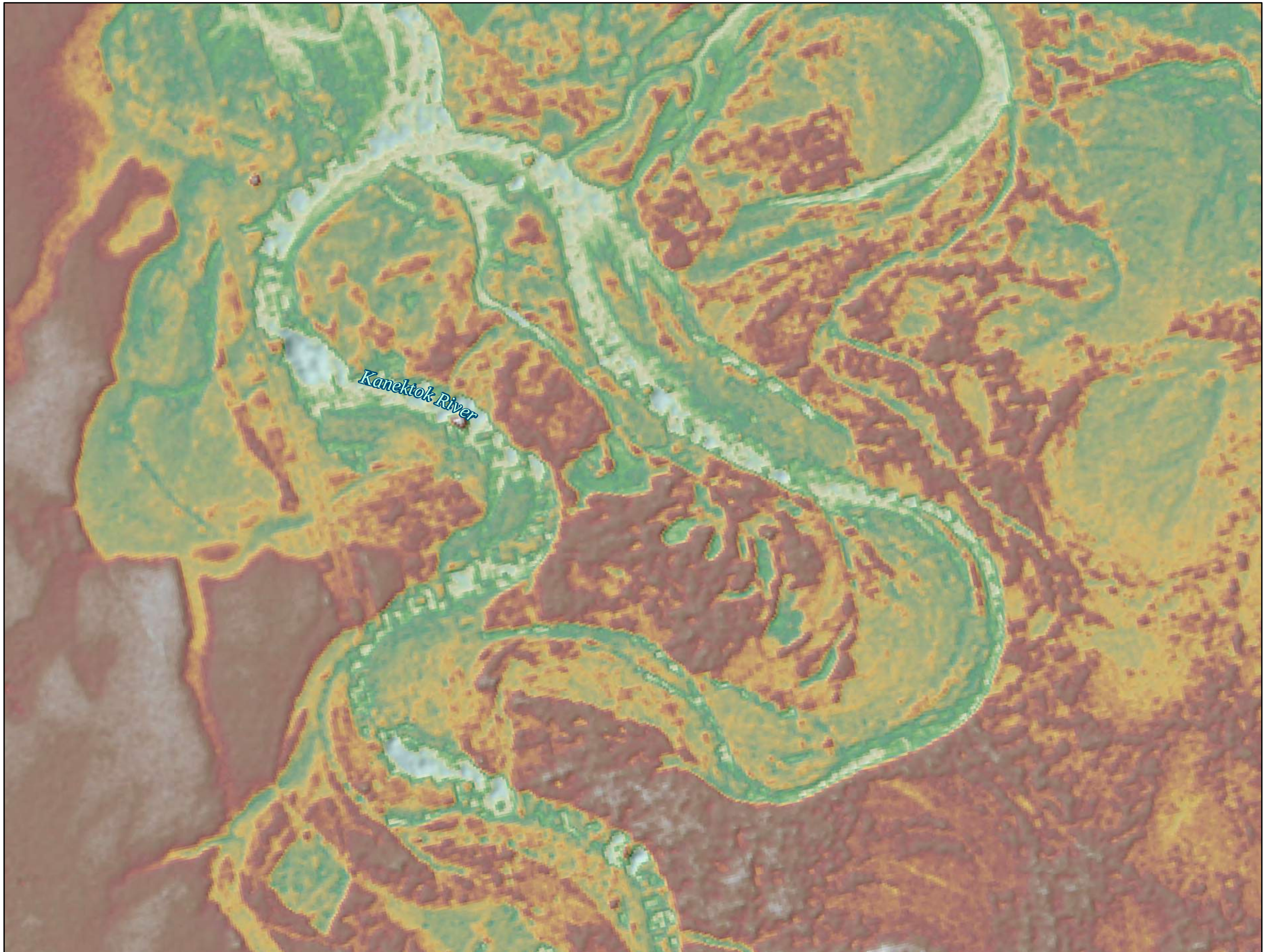
0 300 600 1,200 Feet

HERRERA

NAD 1983 StatePlane Alaska 7 FIPS 5007 (Feet)
Source: Polar Geospatial Center - U. of Minnesota

K:\Projects\Y2018\18-06770-000\Project\GISWorking\Quinhagak_lidar.mxd

LiDAR (4 of 6)
Kanektok River, Quinhagak, Alaska

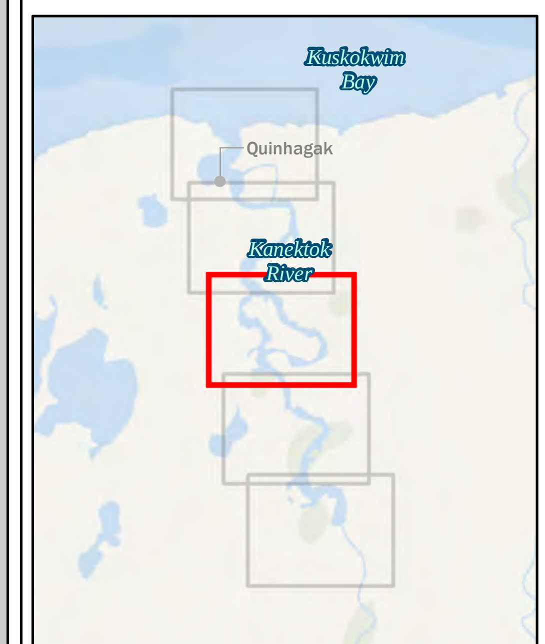


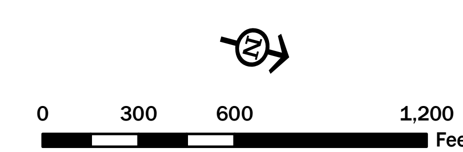
Legend

Elevation (ft)

26

16

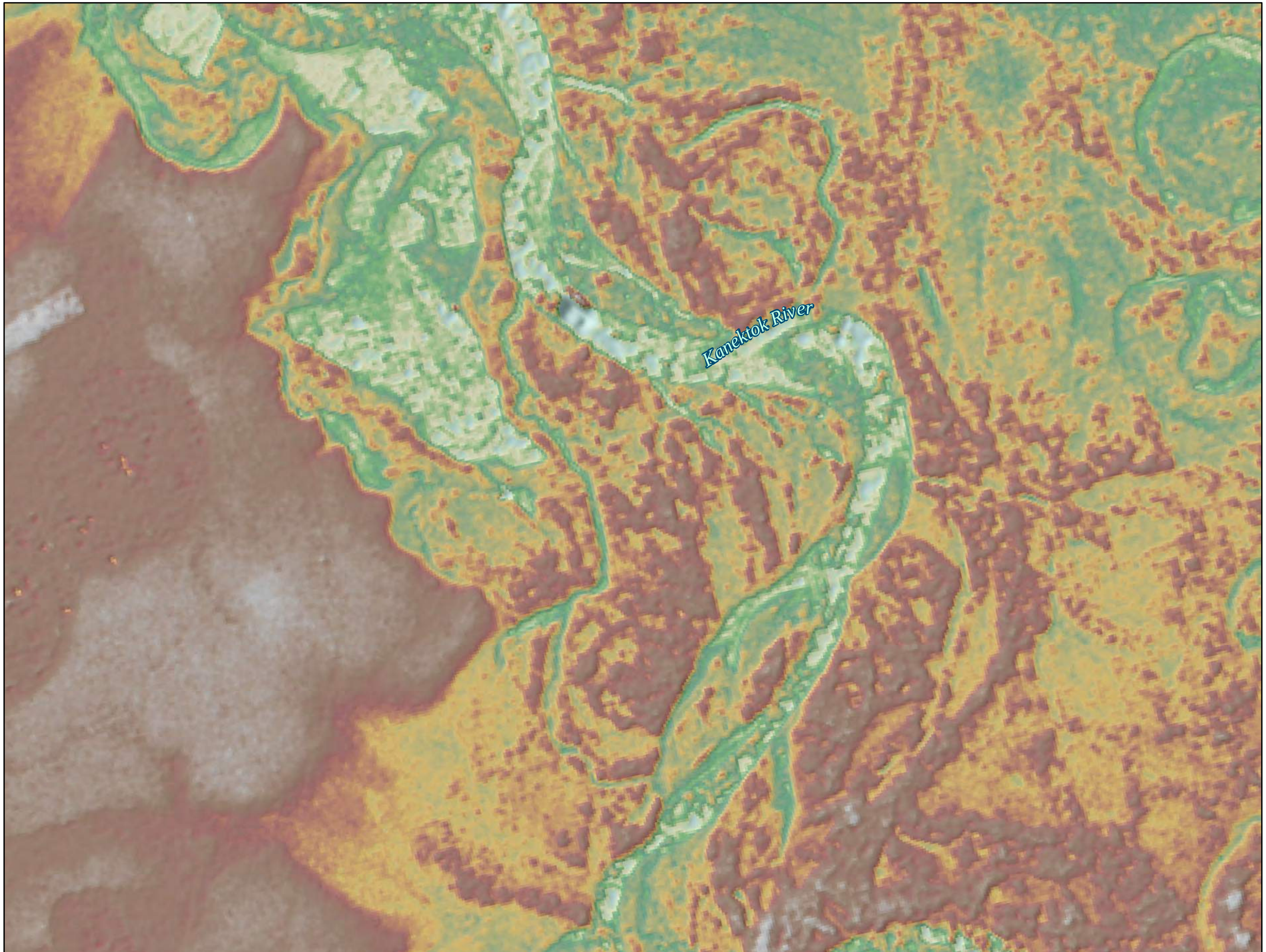




HERRERA

NAD 1983 StatePlane Alaska 7 FIPS 5007 (Feet)
Source: Polar Geospatial Center - U. of Minnesota

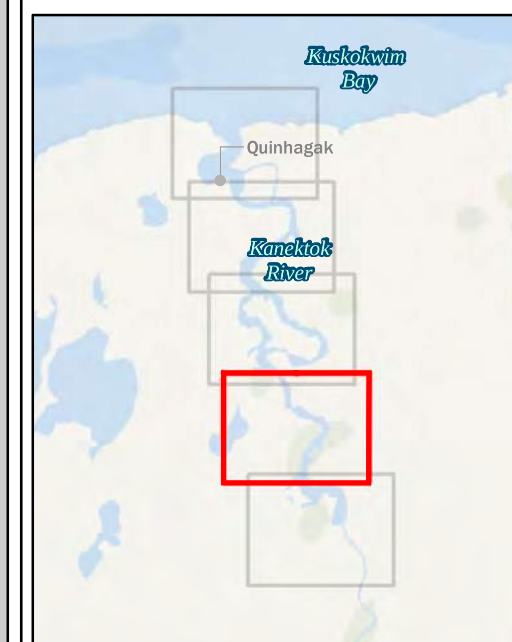
K:\Projects\Y2018\18-06770-000\Project\GISWorking\Quinhagak_lidar.mxd



LiDAR (5 of 6)
Kanektok River, Quinhagak, Alaska

Legend

Elevation (ft)
28
18

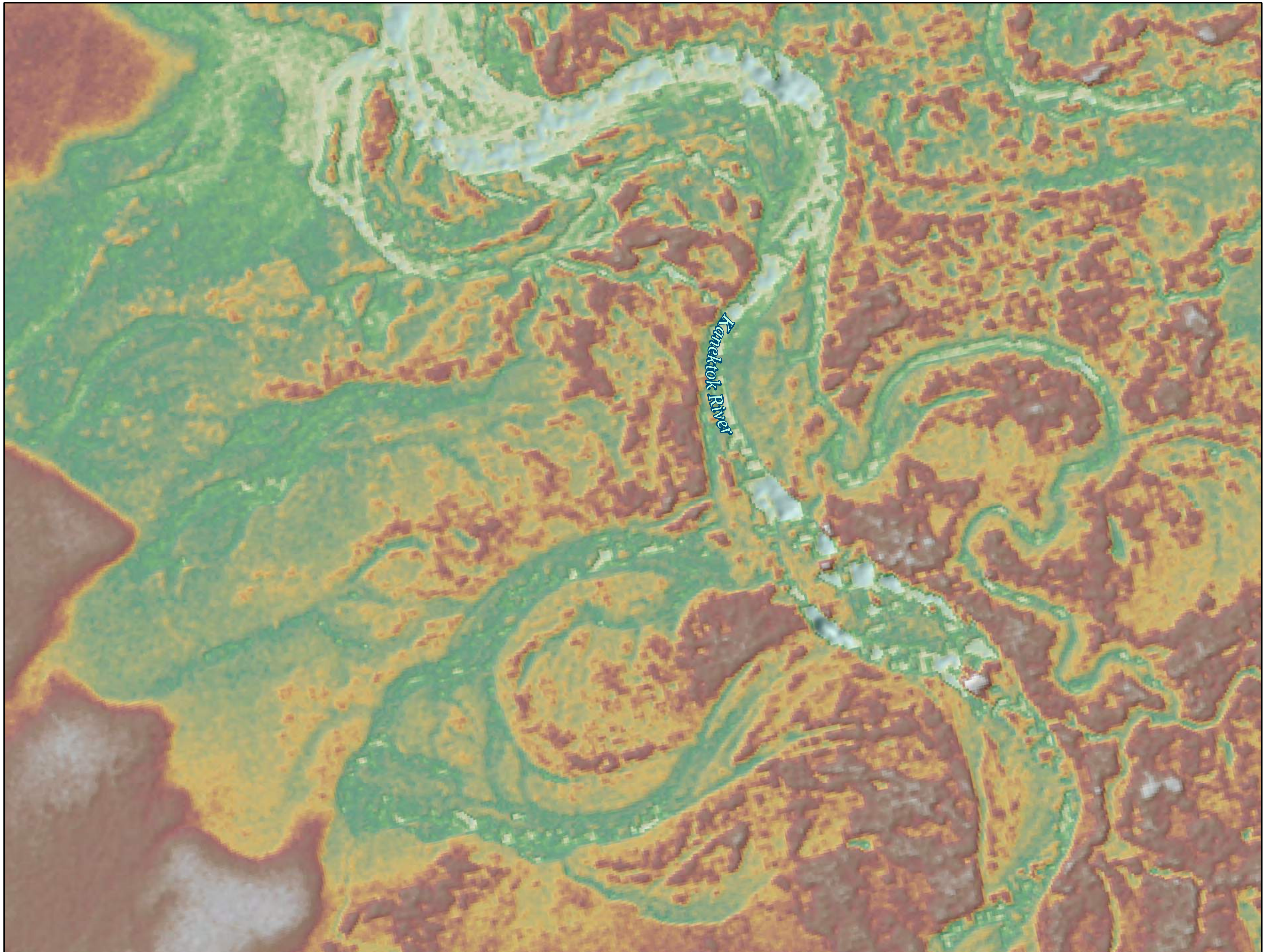


0 300 600 1,200
Feet

HERRERA

NAD 1983 StatePlane Alaska 7 FIPS 5007 (Feet)
Source: Polar Geospatial Center - U. of Minnesota
K:\Projects\Y2018\18-06770-000\Project\GISWorking\Quinhagak_lidar.mxd

LiDAR (6 of 6)
Kanektok River, Quinhagak, Alaska

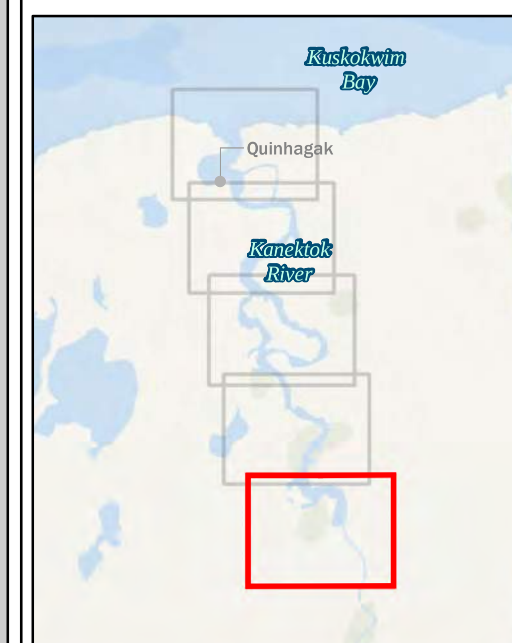


Legend

Elevation (ft)

30

20



0 300 600 1,200
Feet

HERRERA

NAD 1983 StatePlane Alaska 7 FIPS 5007 (Feet)
Source: Polar Geospatial Center - U. of Minnesota

K:\Projects\Y2018\18-06770-000\Project\GISWorking\Quinhagak_lidar.mxd

APPENDIX B

Additional Hydraulic Modeling Results

Figure B-1.
Alternative 1
2 Year Maximum Depth.

Legend

Depth (ft)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 6
- 6.1 to 8
- 8.1 to 10
- >10

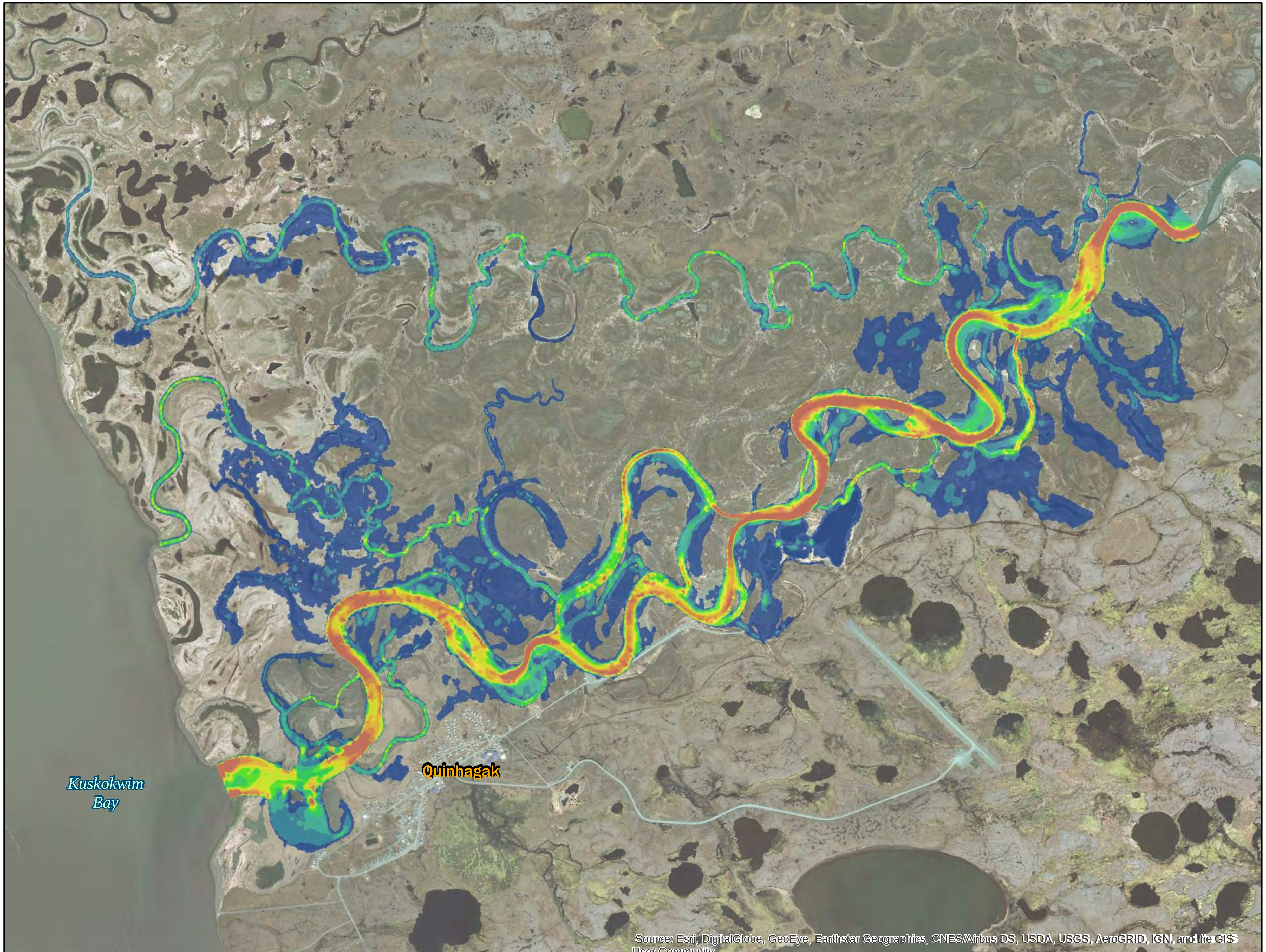
N

0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

Figure B-2.
Alternative 1
2 Year Maximum Velocity.



Legend

Velocity (ft/s)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 4.5
- > 5

N

0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

K:\Projects\Y2018\18-06770-000\Project\GISWorking\DepthAndVelocity_Plots_20180911\FigB2_2y_Alt1Velocity_20180911.mxd

Figure B-3.
Alternative 2
2 Year Maximum Depth.

Legend

Depth (ft)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 6
- 6.1 to 8
- 8.1 to 10
- >10

N

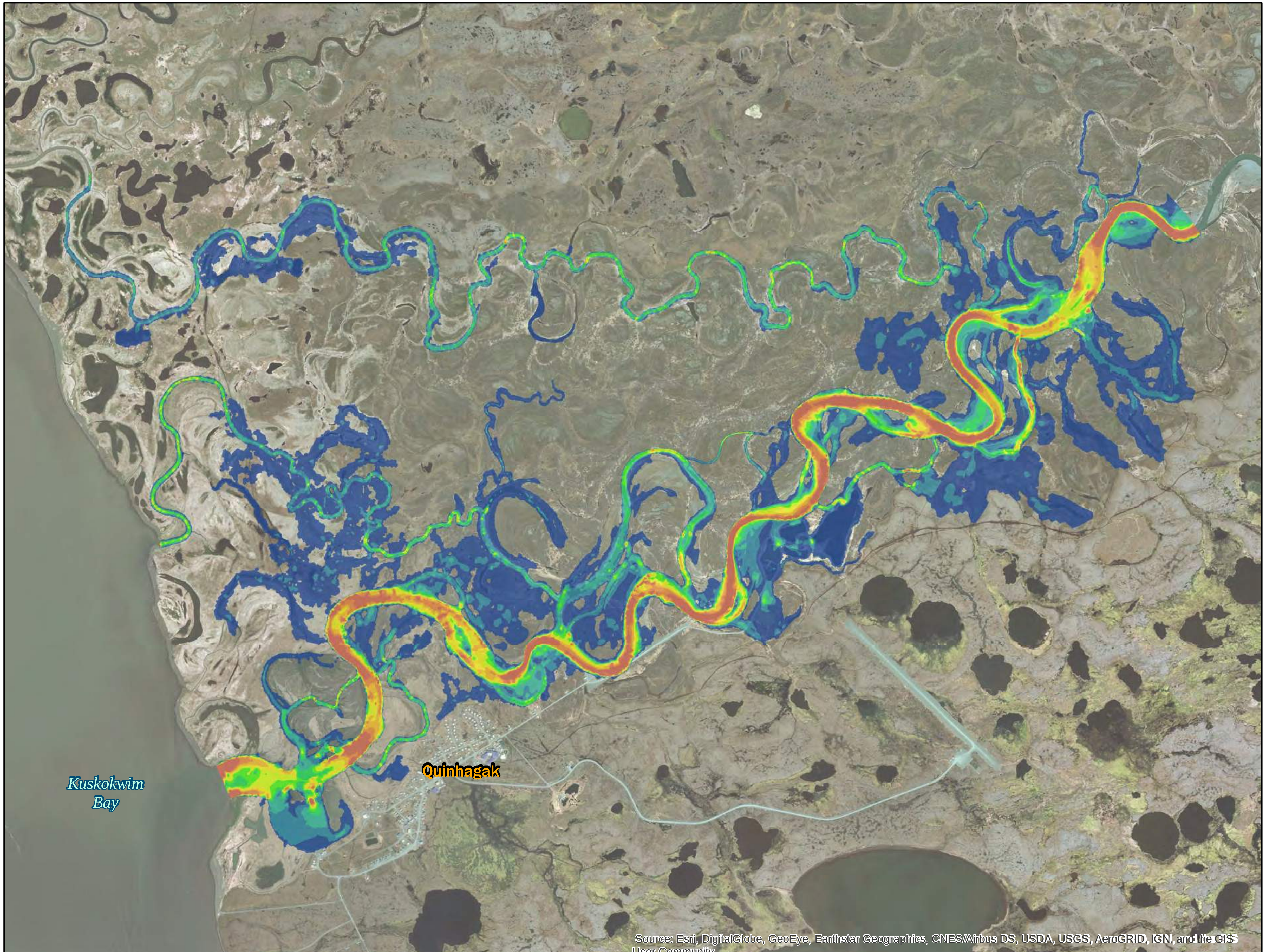
0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

K:\Projects\Y2018\18-06770-000\Project\GISWorking\DepthAndVelocity_Plots_20180911\FigB3_2y_Alt2Depth_20180911.mxd

Figure B-4.
Alternative 2
2 Year Maximum Velocity.



Legend

Velocity (ft/s)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 4.5
- > 5

N

0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

K:\Projects\Y2018\18-06770-000\Project\GISWorking\DepthAndVelocity_Plots_20180911\FigB4_2y_Alt2Velocity_20180911.mxd

Figure B-5.
Alternative 3
2 Year Maximum Depth.

Legend

Depth (ft)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 6
- 6.1 to 8
- 8.1 to 10
- >10

N

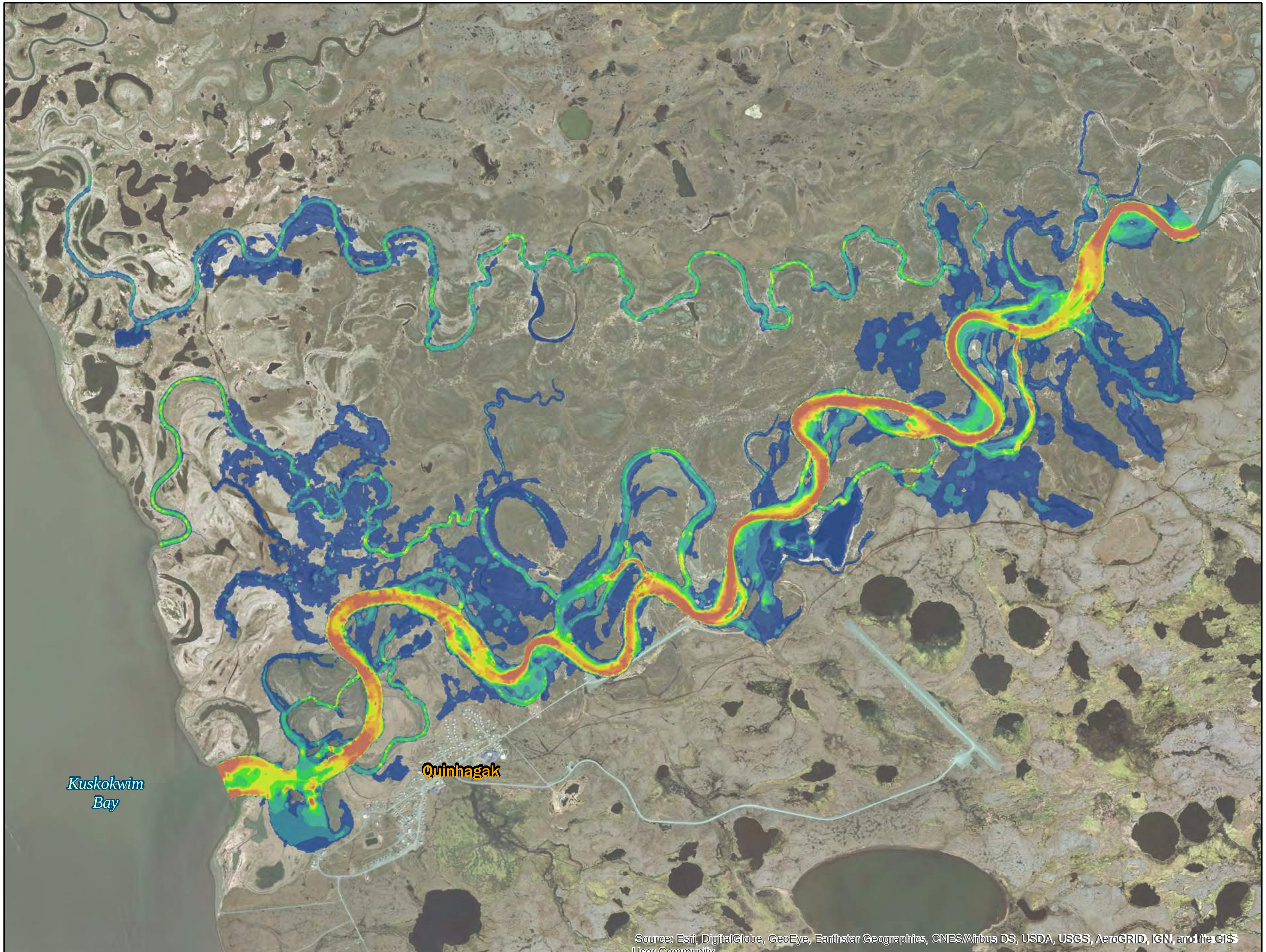
0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

K:\Projects\Y2018\18-06770-000\Project\GISWorking\DepthAndVelocity_Plots_20180911\FigB5_2y_Alt3Depth_20180911.mxd

Figure B-6.
Alternative 3
2 Year Maximum Velocity.



Legend

Velocity (ft/s)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 4.5
- > 5

N

0 1,100 2,200 4,400
Feet

HERRERA

Digital Globe, Aerial (2015)

K:\Projects\Y2018\18-06770-000\Project\GISWorking\DepthAndVelocity_Plots_20180911\FigB6_2y_Alt3Velocity_20180911.mxd

Figure B-7.
Alternative 4
2 Year Maximum Depth.

Legend

Depth (ft)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 6
- 6.1 to 8
- 8.1 to 10
- >10

N

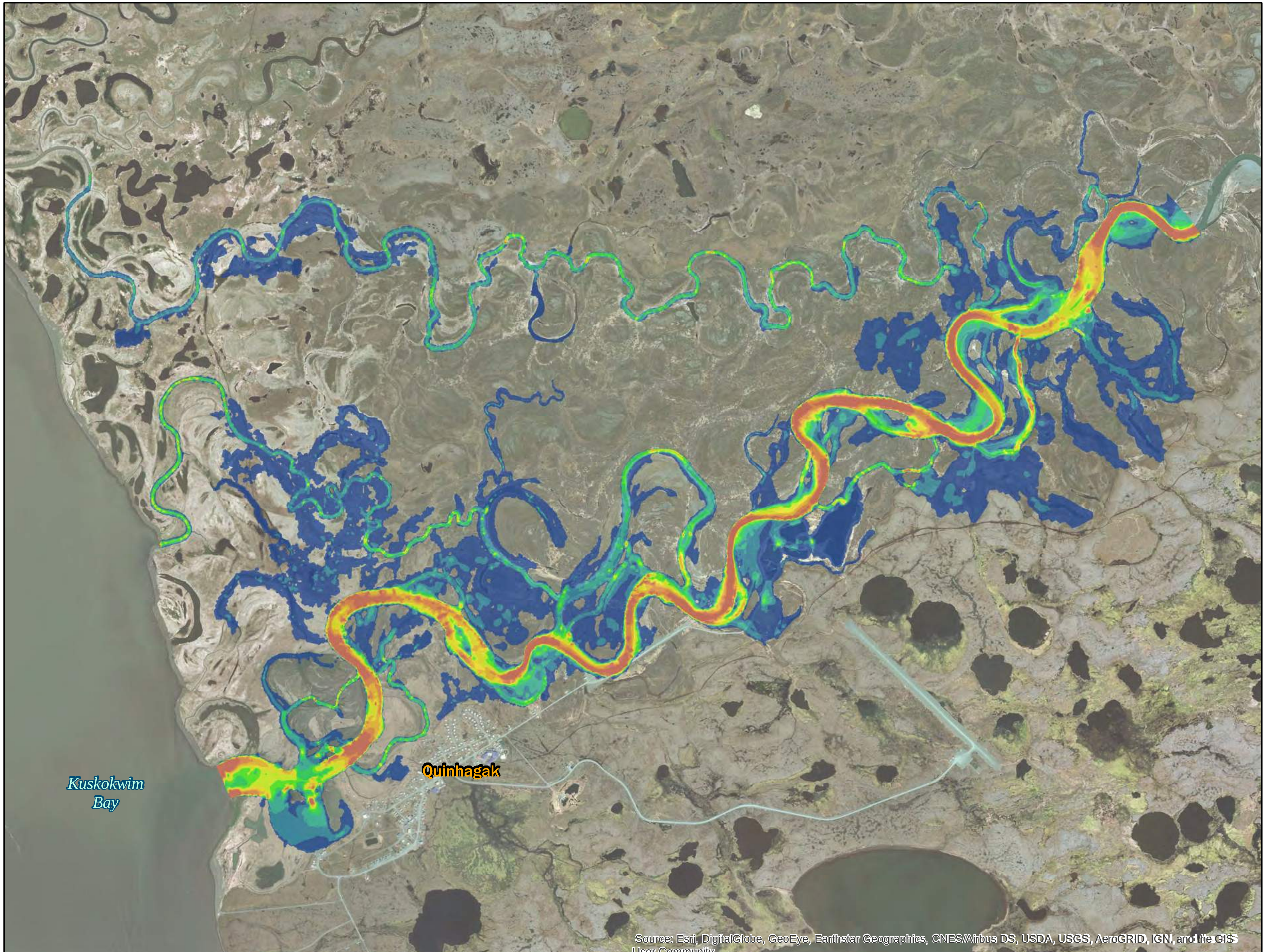
0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

K:\Projects\Y2018\18-06770-000\Project\GISWorking\DepthAndVelocity_Plots_20180911\FigB7_2y_Alt4Depth_20180911.mxd

Figure B-8.
Alternative 4
2 Year Maximum Velocity.



Legend

Velocity (ft/s)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 4.5
- > 5

N

0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

K:\Projects\Y2018\18-06770-000\Project\GISWorking\DepthAndVelocity_Plots_20180911\FigB8_2y_Alt4Velocity_20180911.mxd

Figure B-9.
Alternative 5
2 Year Maximum Depth.

Legend

Depth (ft)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 6
- 6.1 to 8
- 8.1 to 10
- >10

N

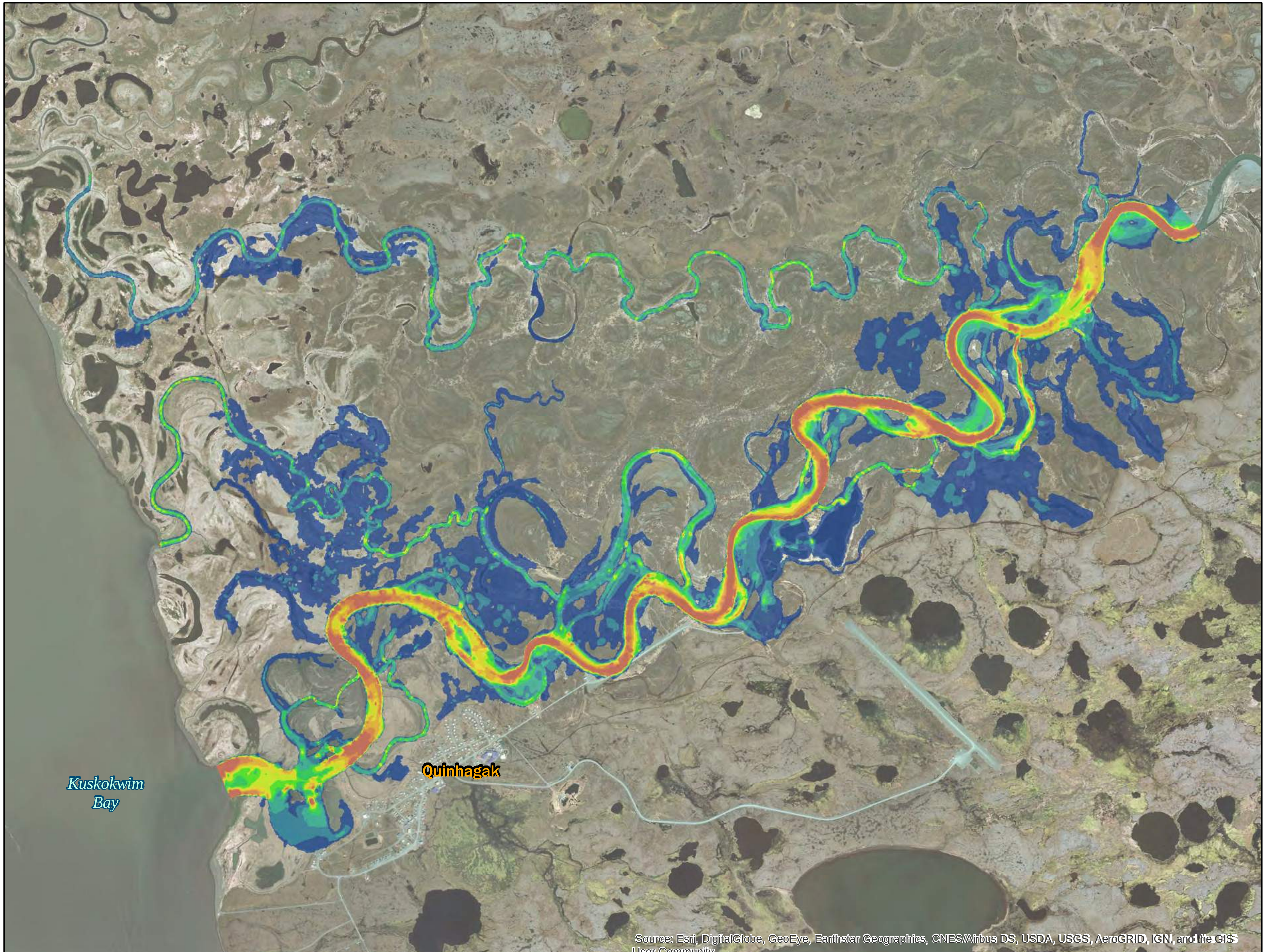
0 1,100 2,200 4,400
Feet

HERRERA

Digital Globe, Aerial (2015)

K:\Projects\Y2018\18-06770-000\Project\GISWorking\DepthAndVelocity_Plots_20180911\FigB9_2y_Alt5Depth_20180911.mxd

Figure B-10.
Alternative 5
2 Year Maximum Velocity.



Legend

Velocity (ft/s)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 4.5
- > 5

N

0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

K:\Projects\Y2018\18-06770-000\Project\GISWorking\DepthAndVelocity_Plots_20180911\FigB10_2y_Alt5Velocity_20180911.mxd

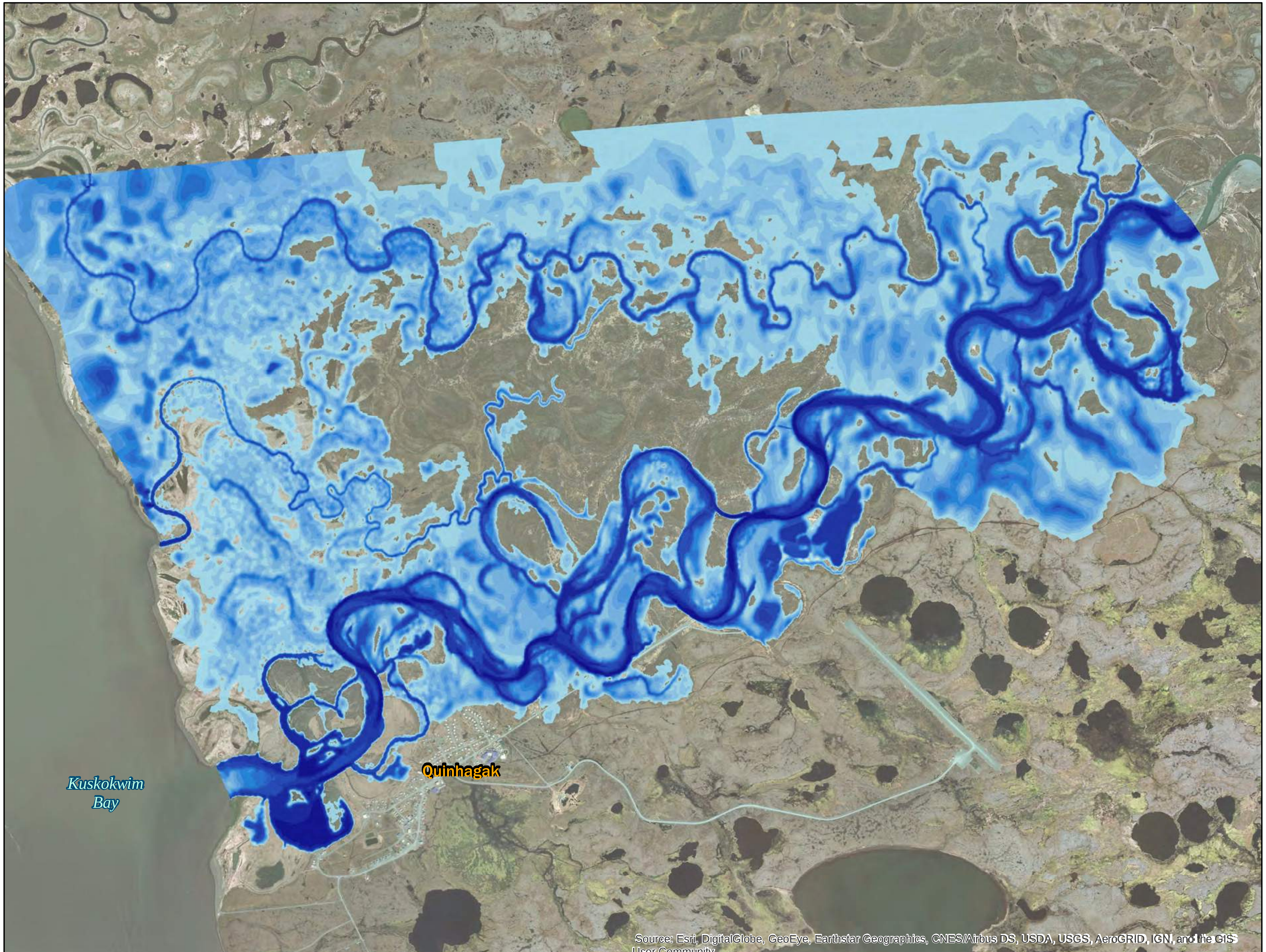


Figure B-11.
Alternative 1
100 Year Maximum Depth.

Legend

Depth (ft)

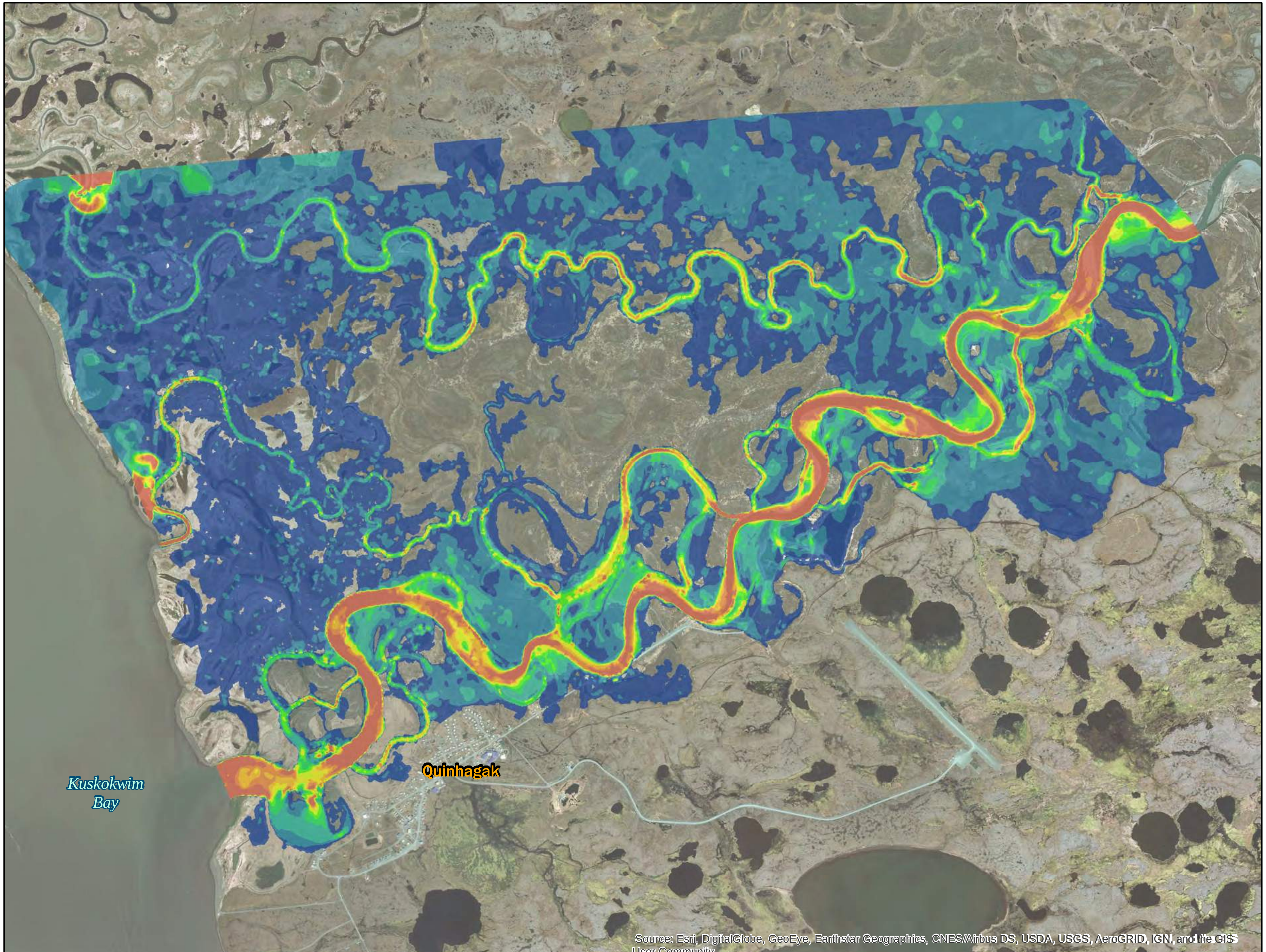
- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 6
- 6.1 to 8
- 8.1 to 10
- >10

0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

Figure B-12.
Alternative 1
100 Year Maximum Velocity.



Legend

Velocity (ft/s)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 4.5
- > 5

N

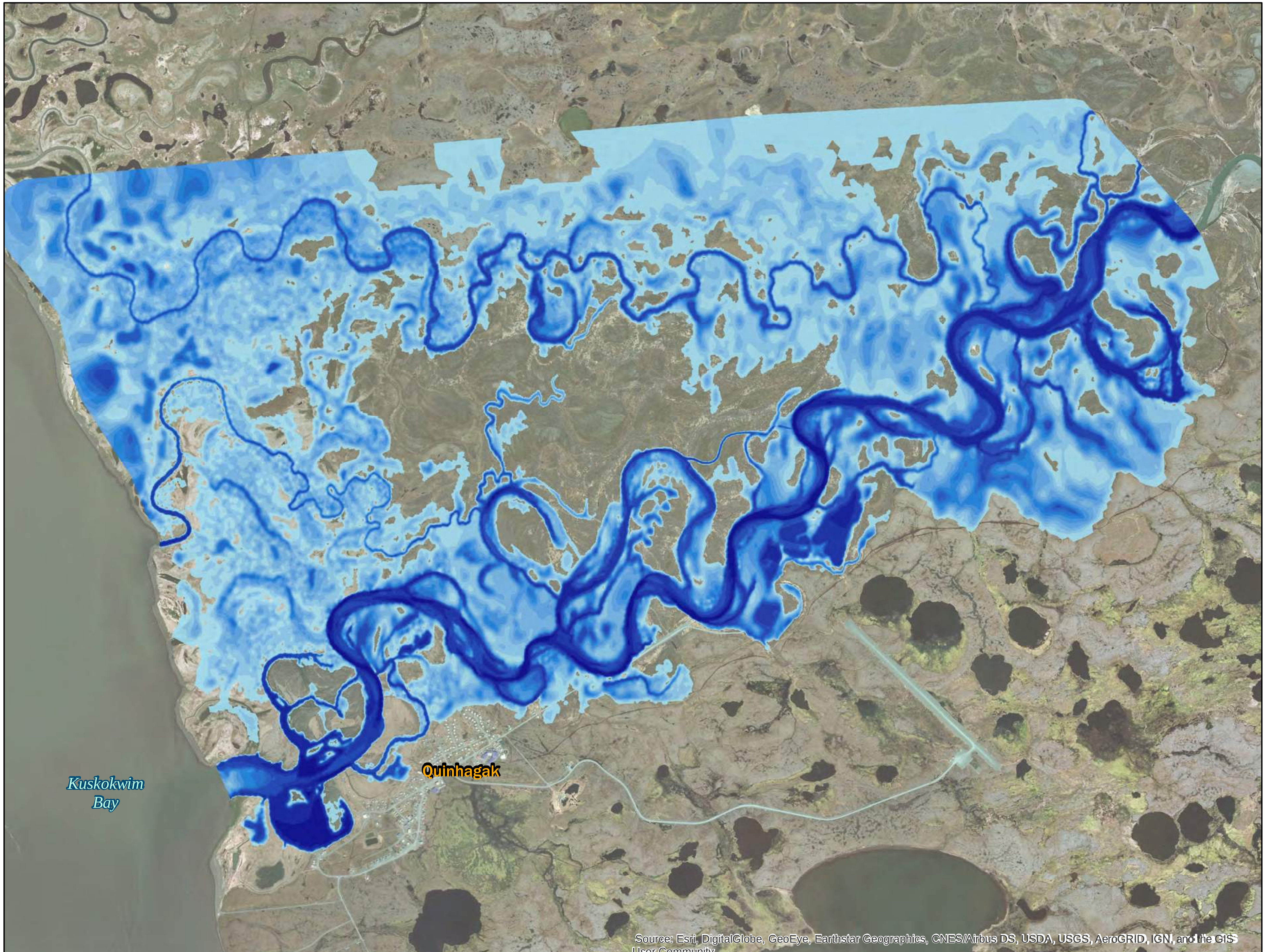
0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

K:\Projects\Y2018\18-06770-000\Project\GISWorking\DepthAndVelocity_Plots_20180911\FigB12_100y_Alt1Velocity_20180911.mxd

Figure B-13.
Alternative 2
100 Year Maximum Depth.



Legend

Depth (ft)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 6
- 6.1 to 8
- 8.1 to 10
- >10

N

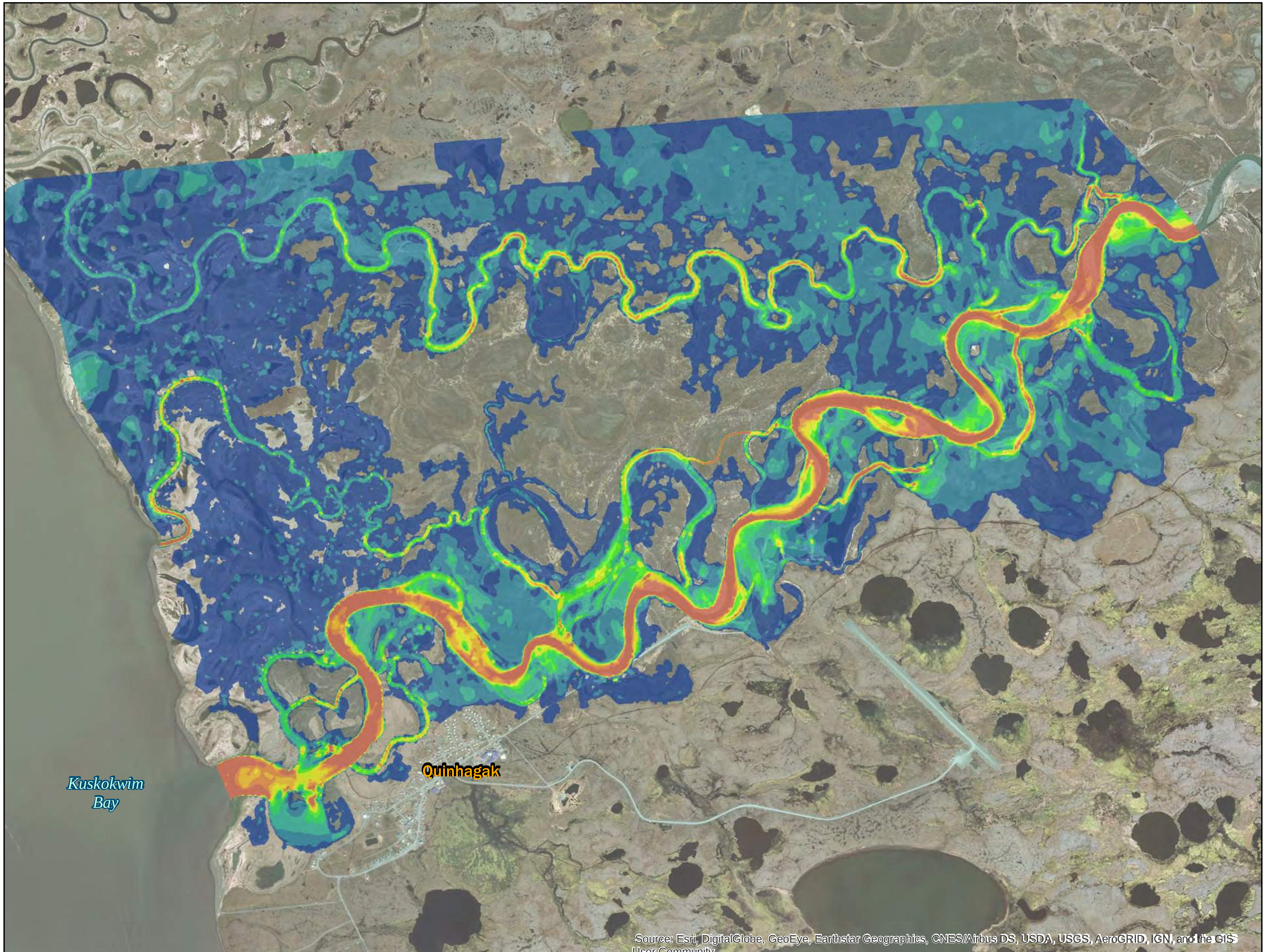
0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

K:\Projects\Y2018\18-06770-000\Project\GISWorking\DepthAndVelocity_Plots_20180911\FigB13_100y_Alt2Depth_20180911.mxd

Figure B-14.
Alternative 2
100 Year Maximum Velocity.



Legend

Velocity (ft/s)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 4.5
- > 5

N

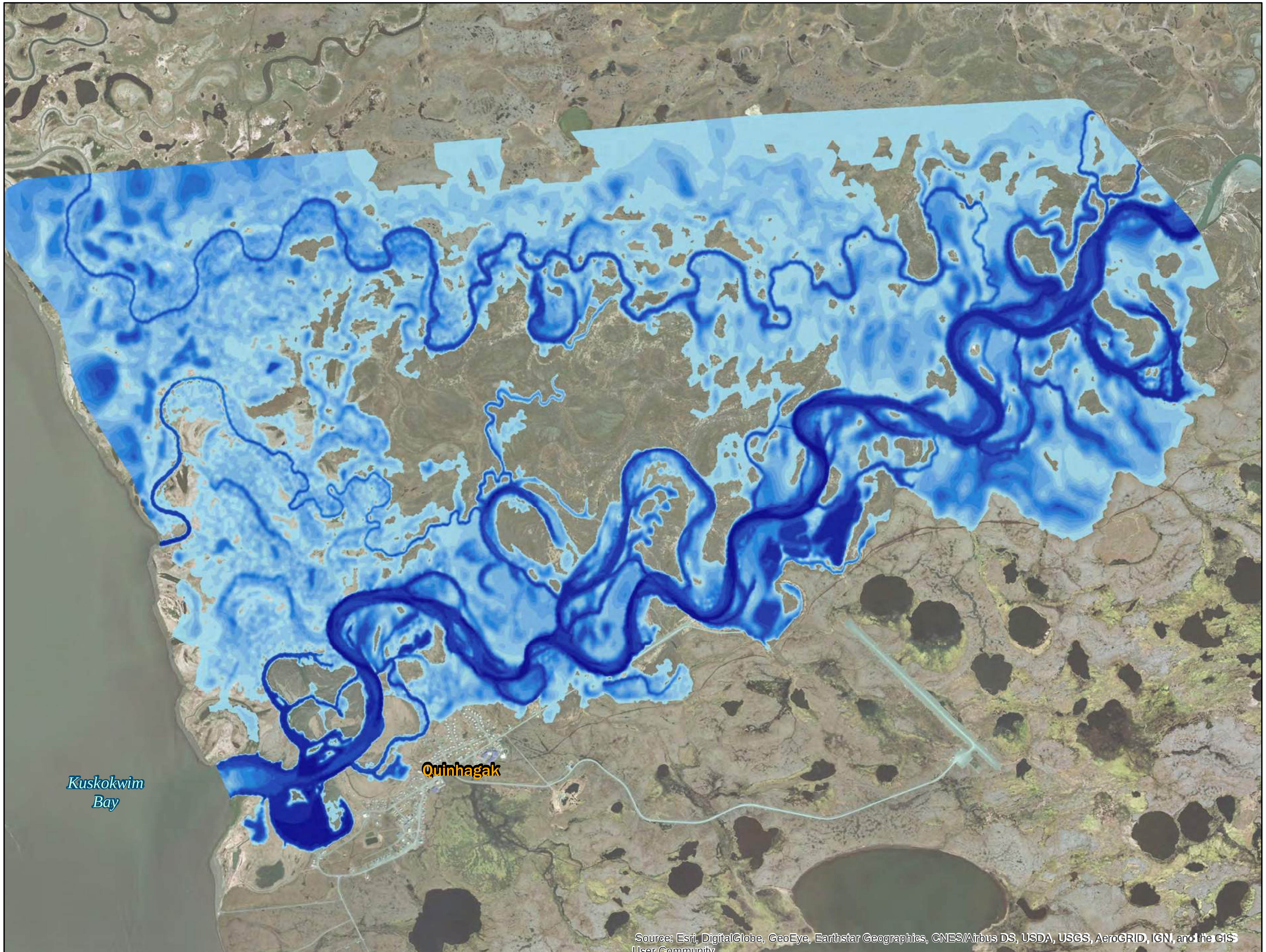
0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

K:\Projects\Y2018\18-06770-000\Project\GISWorking\DepthAndVelocity_Plots_20180911\FigB14_100y_Alt2Velocity_20180911.mxd

Figure B-15.
Alternative 3
100 Year Maximum Depth.



Legend

Depth (ft)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 6
- 6.1 to 8
- 8.1 to 10
- >10

N

0 1,100 2,200 4,400 Feet

Digital Globe, Aerial (2015)

K:\Projects\Y2018\18-06770-000\Project\GISWorking\DepthAndVelocity_Plots_20180911\FigB15_100y_Alt3Depth_20180911.mxd

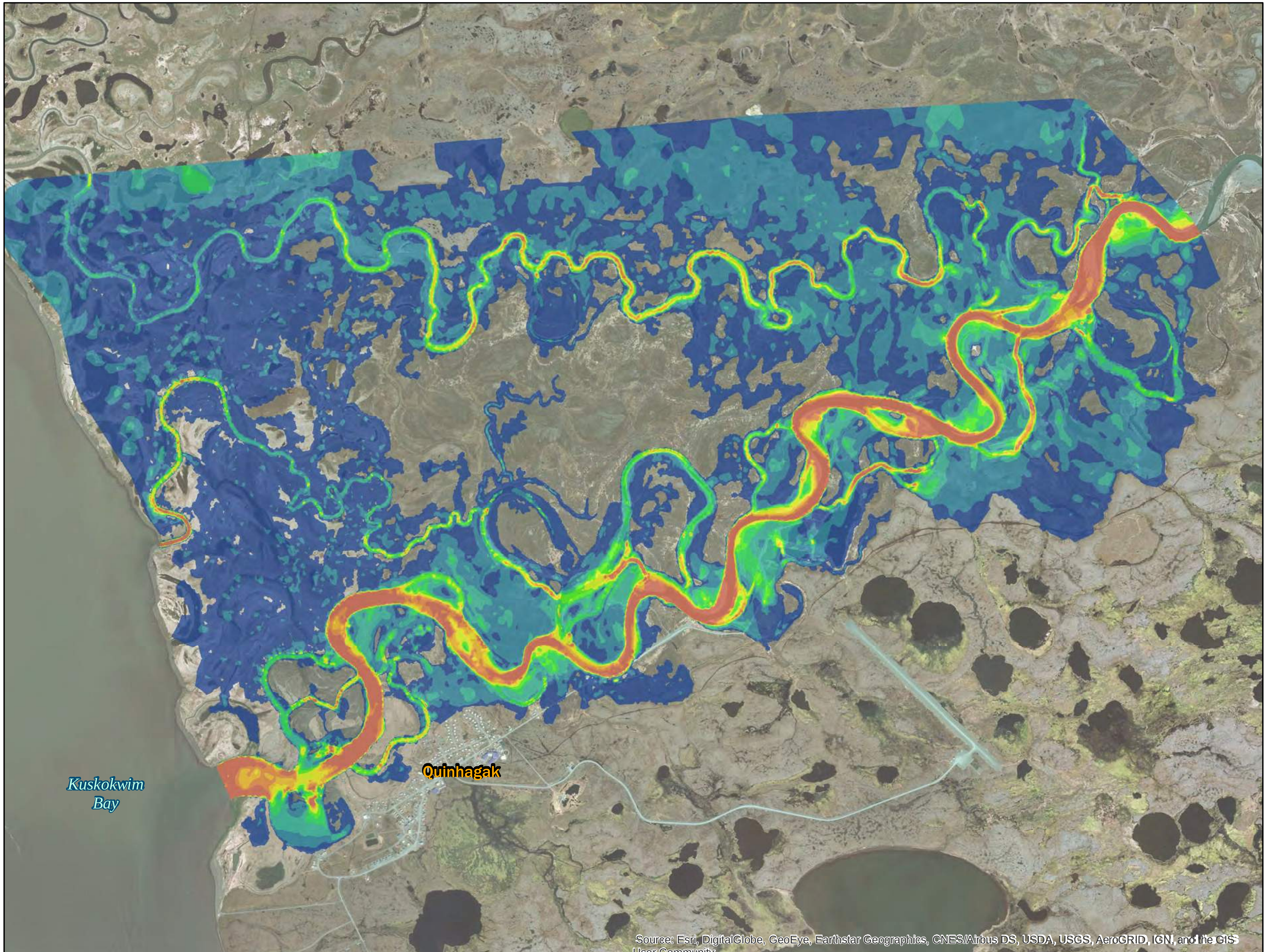


Figure B-16.
Alternative 3
100 Year Maximum Velocity.

Legend

Velocity (ft/s)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 4.5
- > 5

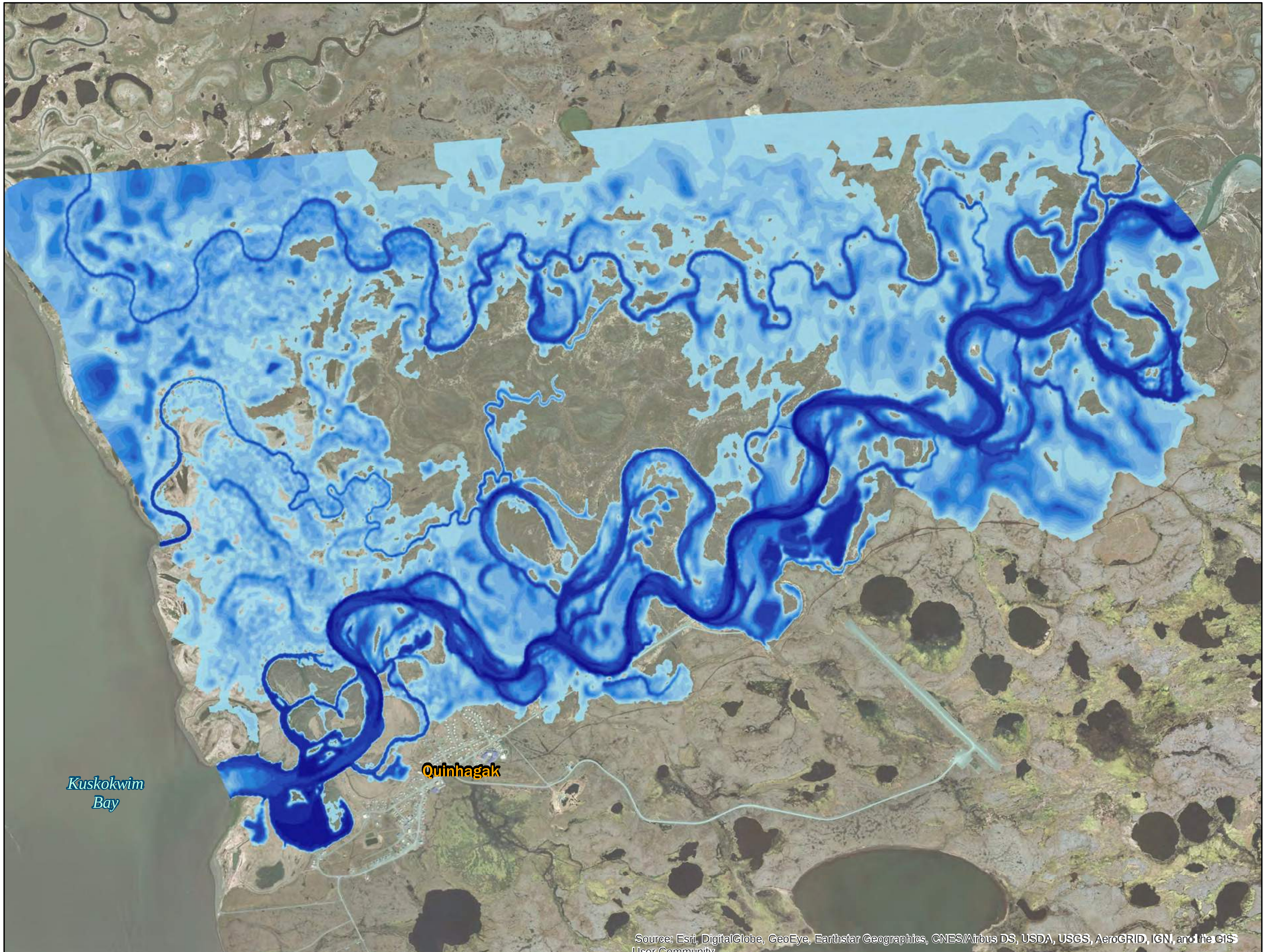
N

0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

Figure B-17.
Alternative 4
100 Year Maximum Depth.



Legend

Depth (ft)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 6
- 6.1 to 8
- 8.1 to 10
- >10

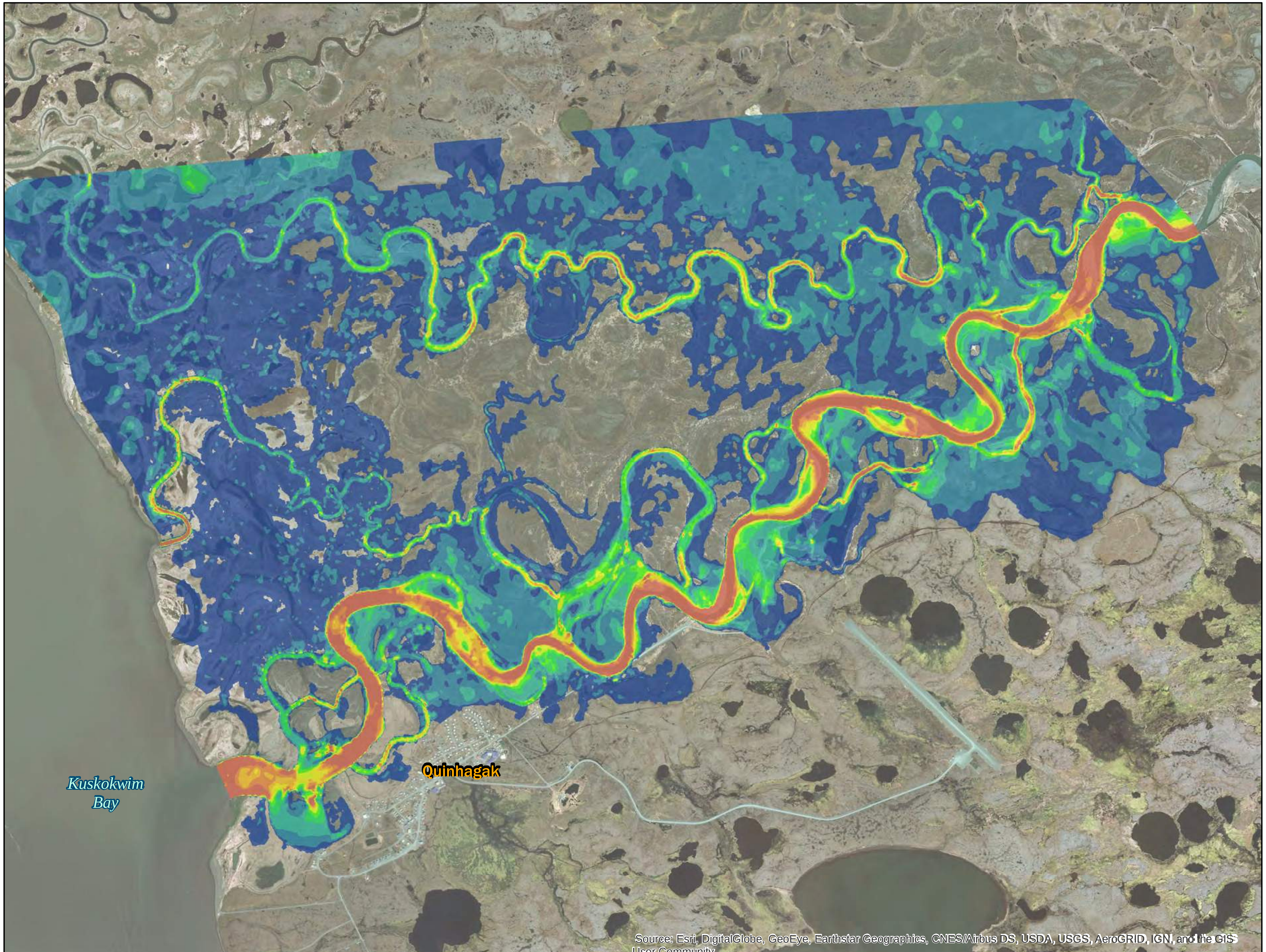
N

0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

Figure B-18.
Alternative 4
100 Year Maximum Velocity.



Legend

Velocity (ft/s)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 4.5
- > 5

N

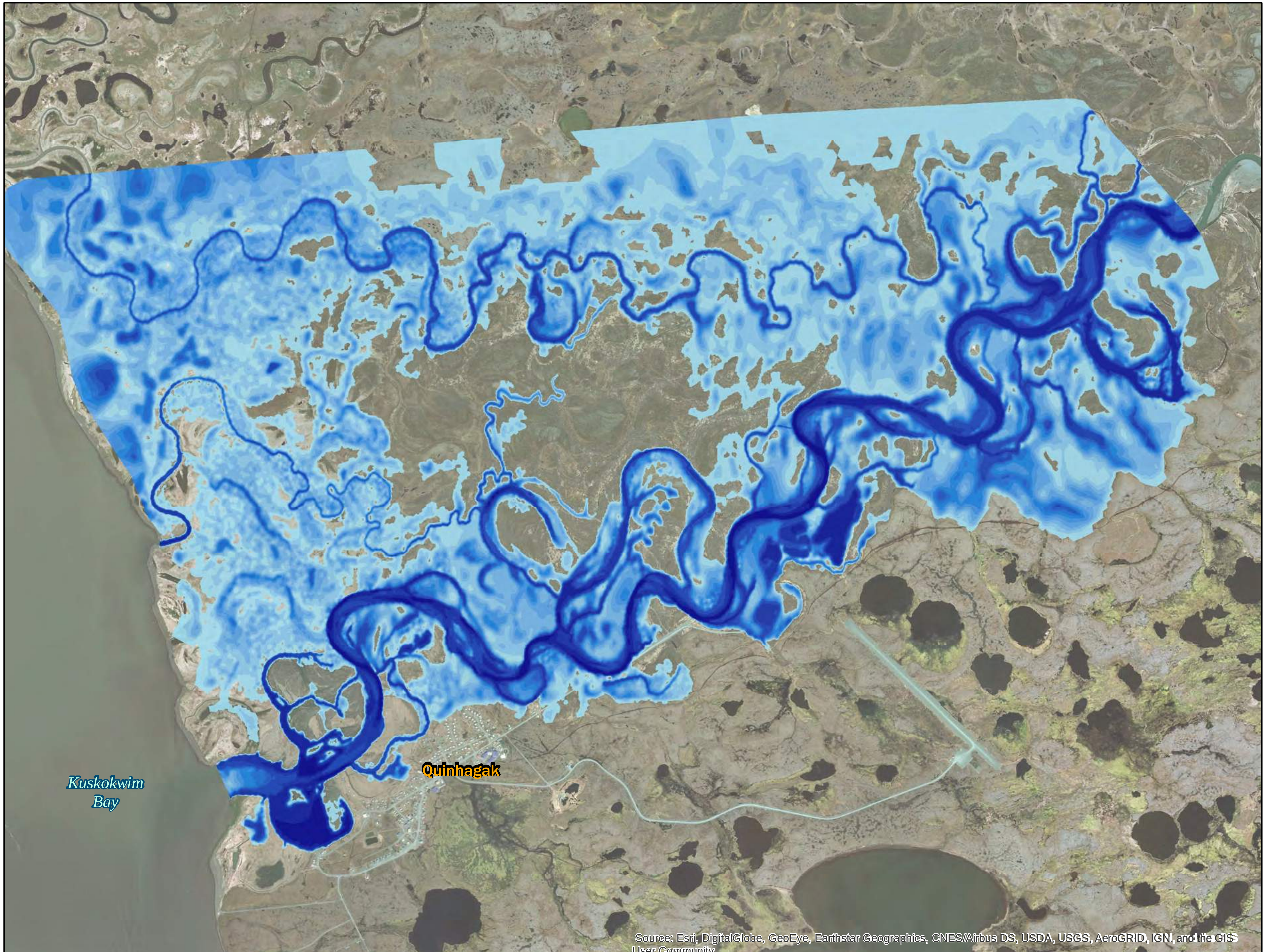
0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

K:\Projects\Y2018\18-06770-000\Project\GISWorking\DepthAndVelocity_Plots_20180911\FigB18_100y_Alt4Velocity_20180911.mxd

Figure B-19.
Alternative 5
100 Year Maximum Depth.



Legend

Depth (ft)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 6
- 6.1 to 8
- 8.1 to 10
- >10

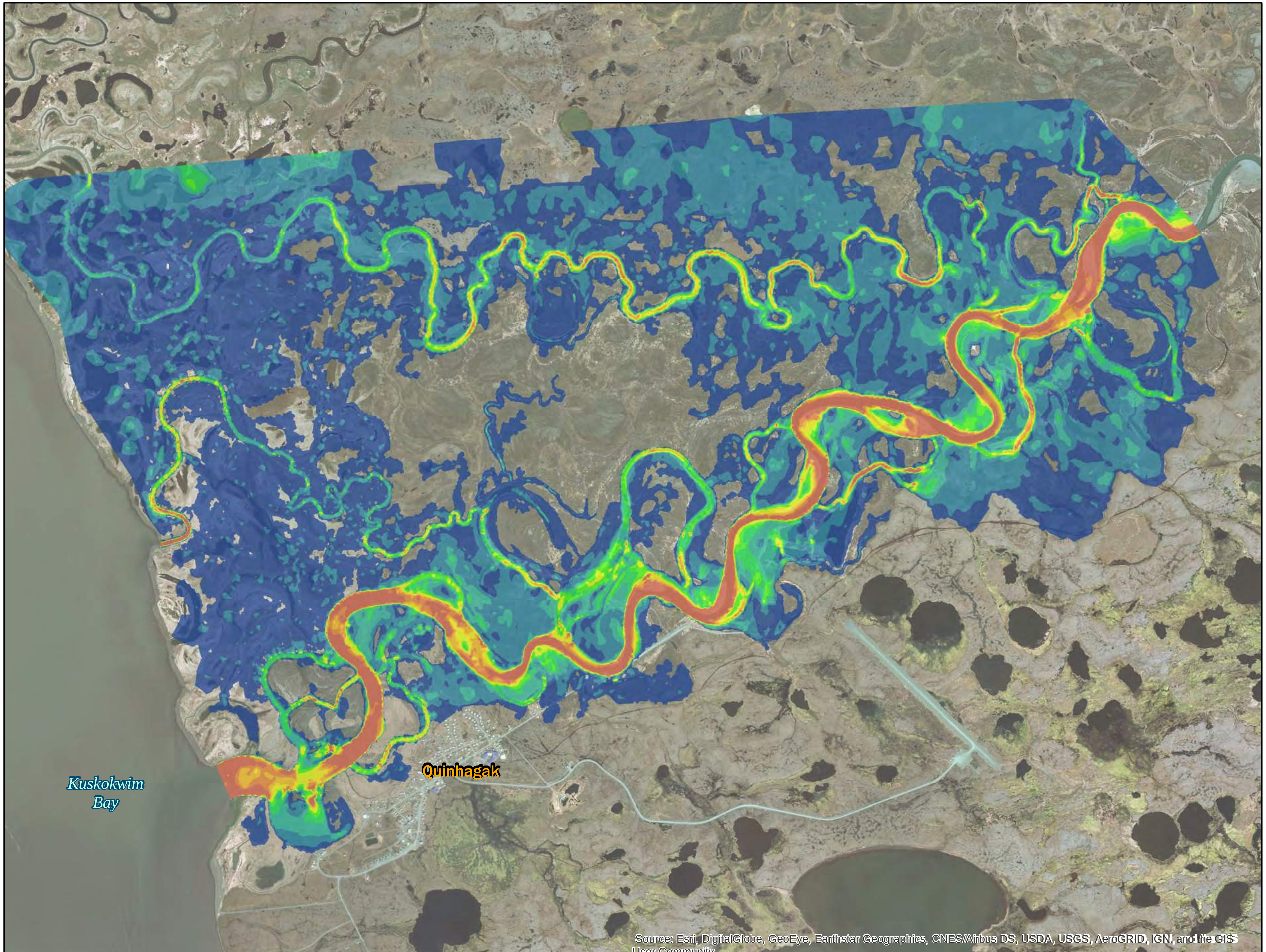
N

0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

Figure B-20.
Alternative 5
100 Year Maximum Velocity.



Legend

Velocity (ft/s)

- < 0.5
- 0.51 to 1
- 1.1 to 1.5
- 1.6 to 2
- 2.1 to 2.5
- 2.6 to 3
- 3.1 to 3.5
- 3.6 to 4
- 4.1 to 4.5
- > 5

N

0 1,100 2,200 4,400 Feet

HERRERA

Digital Globe, Aerial (2015)

K:\Projects\Y2018\18-06770-000\Project\GISWorking\DepthAndVelocity_Plots_20180911\FigB20_100y_Alt5Velocity_20180911.mxd

Appendix C

Site Control

Included in this section:

1. Patent – US Survey No. 9672, Lot 6
2. Native Allotment – US Survey No. 9665, Lot 1
3. Native Allotment – US Survey No. 9665, Lot 2
4. Native Allotment – US Survey No. 9672, Lots 5 & 8

The United States of America

To all to whom these presents shall come, Greeting:

Patent

F-14885-A
F-14885-A2

This patent is issued by the UNITED STATES, Department of the Interior, Bureau of Land Management, 222 West Seventh Avenue, #13, Anchorage, Alaska 99513-7504, as GRANTOR, to Qanirtuuq, Inc, P.O. Box 69, Quinhagak, Alaska 99655, as GRANTEE, for lands in the Bethel Recording District.

WHEREAS

Qanirtuuq, Inc.

is entitled to a patent pursuant to Sec. 14(a) of the Alaska Native Claims Settlement Act of December 18, 1971, 43 U.S.C.§1613(a), of the surface estate in the following-described lands, which were transferred by Interim Conveyance No. 342 issued June 25, 1980 and Interim Conveyance No. 2298 issued December 9, 2009:

Section 12(a) lands

Lots 3, 6, 7, and 9, U.S. Survey No. 9672, Alaska.

Containing 116.40 acres, as shown on the plat of survey officially filed on October 15, 1990.

Lot 5, U.S. Survey No. 9678, Alaska.

Containing 14.80 acres, as shown on the plat of survey officially filed on August 13, 1990.

Seward Meridian, Alaska

T. 7 S., R. 72 W.,
Sec. 23, lots 6 and 7;

Containing 0.13 acres, as shown on plat of survey officially filed April 28, 1994.

T. 7 S., R. 73 W.,
Secs. 6 and 7;
Sec. 18, lots 1 and 2;
Sec. 19;
Sec. 30.

Containing 2,052.78 acres, as shown on plat of survey officially filed April 28, 1994, and dependent resurvey and survey officially filed October 16, 2007.

T. 3 S., R. 74 W.,
Sec. 1, lots 1 to 10, inclusive;
Sec. 12, lots 1 and 2;
Sec. 13, lots 1, 2, and 3;
Sec. 24, lots 1 to 4, inclusive;
Sec. 25, lots 1, 2, and 3;
Sec. 36, lots 1 and 2.

Containing 3,385.97 acres, as shown on plat of survey officially filed April 28, 1994.

T. 4 S., R. 74 W.,
Secs. 1 and 12;
Sec. 13, lots 1, and 2;
Sec. 24.

Containing 1,960.58 acres, as shown on plat of survey officially filed April 28, 1994.

T. 5 S., R. 74 W.,
Sec. 1, lots 1 and 2;
Sec. 2, lots 1 to 4, inclusive, and lot 7;
Sec. 3, lots 1, 2, 4, and 6;

Sec. 4, lots 1 and 3;
Sec. 5, lots 1 and 2;
Sec. 6, lots 1, 2, and 3;
Sec. 7, lots 1 and 2;
Sec. 8, lots 1, 2, 3, 6, 7, 8, 10, and 11;
Sec. 9, lots 1, 2, 4, 6, 7, 9, 10 and 11;
Secs. 10 to 14, inclusive;
Sec. 15, lots 1, 2, and 3;
Sec. 16;
Sec. 17, lots 1, 2, and 3;
Sec. 18, lots 1, 2, and 4;
Secs. 19 to 24, inclusive;
Sec. 25, lots 1 to 4, inclusive;
Sec. 26, lots 1 to 4, inclusive;
Sec. 27, lots 1, 2, and 3;
Sec. 28;
Sec. 29, lots 1 and 2;
Sec. 33, lots 1 to 7, inclusive;
Sec. 34, lots 1 to 5, inclusive;
Sec. 35, lots 1, 2, and 3;
Sec. 36, lots 1, 2, and 3.

Containing 14,467.83 acres, as shown on plat of survey officially filed April 28, 1994, and supplemental plat officially filed March 30, 2007.

Aggregating 21,998.49 acres.

Section 12(b) lands

Seward Meridian, Alaska

T. 5 S., R. 73 W.,
Sec. 1;
Sec. 2, lots 1 and 2;
Sec. 3, lots 1 and 2;
Secs. 10 to 15, inclusive.

Containing 5,613.47 acres, as shown on plat of survey officially filed April 28, 1994.

T. 7 S., R. 73 W.,
Secs. 8 and 17;
Sec. 20, lots 1 and 2;
Sec. 21, lots 1 and 2;
Sec. 28;
Sec. 29, lots 1 and 2;
Secs. 32 and 33.

Containing 4,007.18 acres, as shown on plat of survey officially filed April 28, 1994, and dependent resurvey and survey officially filed October 16, 2007.

T. 3 S., R. 75 W.,
Secs. 24, 25, and 36.

Containing 543.30 acres, as shown on plat of survey officially filed April 28, 1994.

Aggregating 10,163.95 acres.

Total Sec. 12(a) and Sec. 12(b) Aggregating 32,162.44 acres.

NOW KNOW YE, that there is, therefore, granted by the UNITED STATES OF AMERICA, unto the above-named corporation the surface estate in the lands above described; TO HAVE AND TO HOLD the said estate with all the rights, privileges, immunities, and appurtenances, of whatsoever nature, thereunto belonging, unto the said corporation, its successors and assigns, forever.

EXCEPTING AND RESERVING TO THE UNITED STATES from the lands so granted:

1. The subsurface estate therein, and all rights, privileges, immunities, and appurtenances, of whatsoever nature, accruing unto said estate pursuant to the Alaska Native Claims Settlement Act of December 18, 1971, 43 U.S.C. § 1613(f); and

2. Pursuant to Sec. 17(b) of the Alaska Native Claims Settlement Act of December 18, 1971, 43 U.S.C. § 1616(b) (1976), and the administrative record, including easement memoranda, the following public easements,

referenced by Easement Identification Number (EIN) on the easement maps, copies of which can be found in the Bureau of Land Management's public land records, are reserved to the United States. All easements are subject to applicable Federal, State, or Municipal corporation regulation. The following is a listing of uses allowed for each type of easement. Any uses which are not specifically listed are prohibited.

> <u>25 Foot Trail</u> - The uses allowed on a twenty-five (25) foot wide trail easement are: travel by foot, dogsleds, animals, snowmobiles, two- and three-wheeled vehicles, and small all-terrain vehicles (ATV's) (less than 3,000 lbs. Gross Vehicle Weight (GVW)).
>
> <u>Site Easement (Airstrip)</u> - The uses allowed on an airstrip site easement are: aircraft landing, vehicle parking (e.g., aircraft, boats, all-terrain vehicles (ATV's), snowmobiles, cars, trucks), temporary camping, and loading or unloading. Temporary camping, loading or unloading shall be limited to 24 hours.

a. (EIN 1 D1, D9, C3) An easement twenty-five (25) feet in width for an existing access trail from Quinhagak in Sec. 17, T. 5 S., R. 74 W., Seward Meridian, northwesterly to public lands. The uses allowed are those listed for a twenty-five (25) foot wide trail easement. The season of use is limited to winter. This reserved public easement is subject to the State of Alaska's claimed RS 2477 interest for RST 30, known as the Bethel-Quinhagak Trail and RST 173, known as the Quinhagak-Goodnews Bay Trail "if valid."

b. (EIN 2 C5) An easement twenty-five (25) feet in width for a proposed access trail from EIN 1 D1, D9, C3 in Sec. 6, T. 5 S., R. 74 W., Seward Meridian, northeasterly, to public lands. The uses allowed are those listed for a twenty-five (25) foot wide trail easement. The season of use is limited to winter.

c. (EIN 3 D1, C3) An easement twenty-five (25) feet in width for an existing and proposed access trail from Quinhagak in Sec. 17, T. 5 S., R. 74 W., Seward Meridian, easterly, generally paralleling the south side of the Kanetok River to public lands. The uses allowed are those listed for a twenty-five (25) foot wide trail easement. The season of use is limited to winter.

d. (EIN 4 D1, D9, C3) An easement twenty-five (25) feet in width for an existing and proposed access trail from Quinhagak in Sec. 17, T. 5 S., R. 74 W., Seward Meridian, southeasterly, generally paralleling the coast to public lands. The uses allowed are those listed for a twenty-five (25) foot wide trail easement. The season of use is limited to winter.

e. (EIN 22 C5) An easement to establish a clear area adjacent to Quinhagak Airport for the safe operation of aircraft landings and take-offs. This area is to include the land and the space over the land, commencing with the west end of the runway at Quinhagak airport, in Sec. 9, T. 5 S., R. 74 W., Seward Meridian, and extending forward from the runway, one thousand (1000) FEET. The width of the easement will vary from one hundred and fifty (150) feet at the end of the runway, to one thousand one hundred and fifty (1150) feet, at the opposite end. The easement uses reserved include the right to clear and keep clear the above described land from any and all obstructions infringing uon or extending into the Airport Imaginary Surfaces as set forth in Part 77 of the Federal Aviation Regulations, as amended.

THE GRANT OF THE ABOVE-DESCRIBED LANDS IS SUBJECT TO:

1. Valid existing rights therein, if any, including but not limited to those created by any lease, contract, permit, right-of-way, or easement, and the right of the lessee, contractee, permittee or grantee to the complete enjoyment of all rights, privileges, and benefits thereby granted to him. Further, pursuant to Sec. 17(b)(2) of the Alaska Native Claims Settlement Act of December 18, 1971 (ANCSA), 43 U.S.C. § 1616(b)(2) (1976), any valid existing right recognized by ANCSA shall continue to have whatever right of access as is now provided for under existing law;

2. Airport Lease F-19406, containing approximately 79.2 acres, located in Secs. 3, 9 and 10, T. 5 S., R. 74 W., Seward Meridian, Alaska, issued to the State of Alaska, Department of Public Works, Division of Aviation (now the Department of Transportation and Public Facilities), under the provisions of the act of May 24, 1928 (45 Stat. 728-729; 49 U.S.C. 211-214);

3. A right-of-way, F-19207, portions of which are 50 feet and portions 100 feet in width, in Sec. 9, T. 5 S., R. 74 W., Seward Meridian, Alaska, for a Federal Aid Highway, Act of August 27, 1958, as amended, 23 U.S.C. 317; and

4. Requirements of Sec. 14(c) of the Alaska Native Claims Settlement Act of December 18, 1971, 43 U.S.C. § 1613(c), as amended, that the grantee hereunder convey those portions, if any, of the lands hereinabove granted, as are prescribed in said section;

IN TESTIMONY WHEREOF, the undersigned authorized officer of the Bureau of Land Management, in accordance with the provisions of the Act of June 17, 1948 (62 Stat. 476), has, in the name of the United States, caused these letters to be made Patent, and the Seal of the Bureau to be hereunto affixed.

GIVEN under my hand, in Anchorage, Alaska, the nineteenth day of June in the year of our Lord two thousand and thirteen and of the Independence of the United States the two hundred and thirty-seventh.

By________________________
Ron Dunton
Deputy State Director
Division of Lands and Cadastral

Location Index for Recording Information:

Lots 3, 6, 7, and 9, U.S. Survey No. 9672, Secs. 9 and 16, T. 5 S., R. 74 W., Seward Meridian.

Lot 5, U.S. Survey No. 9678, Sec. 34, T. 5 S., R. 74 W., Seward Meridian.

Return Recorded Document to:

Fortier & Mikko
1600 A Street, Suite 101
Anchorage, Alaska 99501

BOOK 57 PAGE 788

AA-31280 386 2753

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
ALASKA STATE OFFICE
222 WEST SEVENTH AVENUE, #13
ANCHORAGE, ALASKA 99513-7599

NATIVE ALLOTMENT

Moses Fox

IT IS HEREBY CERTIFIED THAT the application AA-31280 filed pursuant to the Act of May 17, 1906, as amended, 43 U.S.C. 270-1 to 270-3 (1970), has been approved pursuant to that Act and Section 905(a)(1) of the Alaska National Interest Lands Conservation Act of December 2, 1980, 43 U.S.C. 1634, for the following described land:

Lot 1, U.S. Survey No. 9665, Alaska, situated on the right bank of the Kanektok River approximately 1 mile northeasterly of the city of Quinhagak, Alaska.

Containing 79.96 acres, as shown on the plat of survey officially filed on August 13, 1990.

Lot 2, U.S. Survey No. 9531, Alaska, situated on the easterly shore of Kuskokwim Bay, approximately 6 miles northwesterly of the city of Quinhagak, Alaska.

Containing 39.97 acres, as shown on the plat of survey officially filed on August 13, 1990.

Lot 2, U.S. Survey No. 9532, Alaska, situated on the easterly shore of Kuskokwim Bay at the confluence with Oyak Creek approximately 3 miles northwesterly of the city of Quinhagak, Alaska.

Containing 39.98 acres, as shown on the plat of survey officially filed on August 13, 1990.

Aggregating 159.91 acres.

Therefore, let it be known that, pursuant to the said Act of May 17, 1906, as amended, and Section 905(a)(1) of ANILCA the land

CERTIFICATE NO. 50-92-0183

AA-31280

above-described shall be deemed the homestead of the allottee and his heirs in perpetuity, and shall be inalienable and nontaxable until otherwise provided by Congress or until the Secretary of the Interior or his delegate, pursuant to the provisions of the said Act of May 17, 1906, as amended, approves a deed of conveyance vesting in the purchaser a complete title to the land.

EXCEPTING AND RESERVING TO THE UNITED STATES:

1. A right-of-way thereon for ditches or canals constructed by the authority of the United States. Act of August 30, 1890, 43 U.S.C. 945; and

2. All the oil and gas in the land so allotted, and to it, or persons authorized by it, the right to prospect for, mine, and remove such deposits from the same upon compliance with the conditions and subject to the provisions and limitations of the Act of March 8, 1922, as amended, 43 U.S.C. 270-11 and 270-12.

THE GRANT OF THE ABOVE DESCRIBED LAND IS SUBJECT TO:

The continued right of public access along the non-exclusive use Bethel to Platinum winter trail not to exceed 25 feet in width as to Lot 2, U.S. Survey No. 9531, Alaska, and Lot 2, U.S. Survey No. 9532, Alaska.

Ann Johnson

Ann Johnson
Chief, Branch of Calista Adjudication

Dated at ANCHORAGE, ALASKA

on FEBRUARY 0 4 1992

Grantee Address:
Moses Fox
General Delivery
Quinhagak, Ak 99655

Submitted for record in the
Bethel Recording District,
After Recording return to:
AVCP Realty
Pouch 219
Bethel, Ak 99559

CERTIFICATE NO. 50-92-0183

986 2753

BOOK 57 PAGE 790

AVCP REALTY
BOK 219
BETHEL 99559

92-365

RECORDED - ~~FILED~~ 21

BETHEL REC. DIST.

DATE 3-10, 1992

TIME 11:17 A M

Requested by AVCP

Address

K

801185

AA-37775
Parcel B

BOOK 57 PAGE 542

985 2277

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
ALASKA STATE OFFICE
222 WEST SEVENTH AVENUE, #13
ANCHORAGE, ALASKA 99513-7599

NATIVE ALLOTMENT

Martha Oldfriend

IT IS HEREBY CERTIFIED THAT the application AA-37775, Parcel B filed pursuant to the Act of May 17, 1906, as amended, 43 U.S.C. 270-1 to 270-3 (1970), has been approved pursuant to that Act and Section 905(a)(1) of the Alaska National Interest Lands Conservation Act of December 2, 1980, 43 U.S.C. 1634, for the following described land:

> Lot 2, U.S. Survey No. 9665, Alaska, situated on the right bank of the Kanektok River approximately 1 mile northeasterly of the city of Quinhagak, Alaska.

Containing 50.00 acres, as shown on the plat of survey officially filed on August 13, 1990.

Therefore, let it be known that, pursuant to the said Act of May 17, 1906, as amended, and Section 905(a)(1) of the said Alaska National Interest Lands Conservation Act, the land above-described shall be deemed the homestead of the allottee and her heirs in perpetuity, and shall be inalienable and nontaxable until otherwise provided by Congress or until the Secretary of the Interior or his delegate, pursuant to the provisions of the said Act of May 17, 1906, as amended, approves a deed of conveyance vesting in the purchaser a complete title to the land.

EXCEPTING AND RESERVING TO THE UNITED STATES:

1. A right-of-way thereon for ditches or canals constructed by the authority of the United States. Act of August 30, 1890, 43 U.S.C. 945; and

2. All the oil and gas in the land so allotted, and to it, or persons authorized by it, the right to prospect for, mine, and remove such deposits from the same upon compliance with the conditions and subject to the provisions and limitations of the Act of March 8, 1922, as amended, 43 U.S.C. 270-11 and 270-12.

CERTIFICATE NO. 50-92-0021

AA-37775
Parcel B

BOOK 57 PAGE 543

This certificate is supplemental to Certificate No. 50-91-0484 issued on August 21, 1991, and is for the purpose of conveying the remaining portion of the land the allottee is entitled to receive under the Act of May 17, 1906.

Ann Johnson
Ann Johnson
Chief, Branch of Calista Adjudication

Dated at ANCHORAGE, ALASKA

on OCTOBER 2 1 1991

91 OCT 24 AM 11:36

Grantees Address:
Martha Oldfriend
P.O. Box 25
Quinhagak, Ak 99655

Submitted for record in the
Bethel Recording District.
After recording, return to:
AVCP Realty
Pouch 219
Bethel, Ak 99559

92-174

RECORDED - ~~FILED~~ 18'
BETHEL REC. DIST.
DATE 2-4 19 92
TIME 10:19 A M
AVCP REALTY

801082

CERTIFICATE NO. 50-92-0021

AA-37768
Parcel D

986 3403

BOOK 61 PAGE 195

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
ALASKA STATE OFFICE
222 WEST SEVENTH AVENUE, #13
ANCHORAGE, ALASKA 99513-7599

SUPPLEMENTAL NATIVE ALLOTMENT

John Johnson

IT IS HEREBY CERTIFIED THAT the application AA-37768, Parcel D, filed pursuant to the Act of May 17, 1906, as amended, 43 U.S.C. 270-1 to 270-3 (1970), repealed with a savings provision by the Alaska Native Claims Settlement Act of December 18, 1971, 43 U.S.C. 1617(a) (1988), has been approved pursuant to that Act and Section 905(a)(1) of the Alaska National Interest Lands Conservation Act of December 2, 1980, 43 U.S.C. 1634 (1988), for the following described land:

Lots 5 and 8, U.S. Survey No. 9672, Alaska, situated on the left bank of the Kanektok River at the city of Quinhagak, Alaska.

Containing 39.99 acres, as shown on the plat of survey officially filed on October 15, 1990.

Therefore, let it be known that, pursuant to the Act of May 17, 1906, as amended, and Section 905(a)(1) of the Alaska National Interest Lands Conservation Act, the land above-described shall be deemed the homestead of the allottee and his heirs in perpetuity, and shall be inalienable and nontaxable until otherwise provided by Congress or until the Secretary of the Interior or his delegate, pursuant to the provisions of the Act of May 17, 1906, as amended, approves a deed of conveyance vesting in the purchaser a complete title to the land.

Certificate No. 50-93-0275

AA-37768
Parcel D

BOOK 61 PAGE 196

EXCEPTING AND RESERVING TO THE UNITED STATES:

Grantees address:
John Johnson
General Delivery
Quinhagak, AK 99655

Submitted for record in the Bethel Recording District.
After recording return to:
AVCP Realty
P.O. BOX 219
Bethel, AK 99559

1. A right-of-way thereon for ditches or canals constructed by the authority of the United States. Act of August 30, 1890, 43 U.S.C. 945 (1988); and

2. All the oil and gas in the land so allotted, and to it, or persons authorized by it, the right to prospect for, mine, and remove such deposits from the same upon compliance with the conditions and subject to the provisions and limitations of the Act of March 8, 1922, as amended, 43 U.S.C. 270-11 (1982) (repealed, with savings clause, effective 1986) and 270-12 (1982) (amended, with savings clause, effective 1986).

This certificate is supplemental to Certificate No. 50-91-0611, issued on September 30, 1991, and is for the purpose of conveying the remaining portion of the land the allottee is entitled to receive under the Act of May 17, 1906.

Ann Johnson
Ann Johnson
Chief, Branch of Calista Adjudication

Dated at ANCHORAGE, ALASKA
on JUNE 10 1993

93-1040
18-
RECORDED-FILED
BETHEL RECORDING
DISTRICT
JUL 19 10 27 AM '93
REQUESTED BY AVCP REALTY
ADDRESS

986 3403

Certificate No. 50 - 93 - 0275

Appendix D

Cost Estimates

Included in this section:

1. Alternative 1 Cost Estimate
2. Alternative 2 Cost Estimate
3. Alternative 3 Cost Estimate
4. Alternative 4 Cost Estimate
5. Alternative 4.1 Cost Estimate
6. Alternative 5 Cost Estimate
7. Alternative 5.1 Cost Estimate
8. Alternative 6 Cost Estimate

Conceptual Capital Cost Estimate

Alternative No. 1 - Channel Re-route (Mid Route)

Project Duration 8 weeks

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Per Diem		448	day	$60	$26,880
Superintendent		8	weeks	$7,200	$57,600
Project Manager	8 hrs/week	8	weeks	$800	$6,400
Expeditor	40 hrs/week	8	weeks	$2,800	$22,400
Roundtrip Air Fare		6	each	$1,000	$6,000
Allowance for Misc Air Freight		1	ls	$25,000	$25,000
Survey		1	ls	$40,000	$40,000
Equipment Mobilization		1	ls	$210,000	$210,000
Meetings/Coordination					
Project Meetings		16	hours		$1,600
Project Schedule		2	months	$200	$400
Shop Drawings		32	hours		$3,200
Equipment					
Pickup (2 each)	Rental/Ownership Cost	8	weeks	$300	$2,400
Flatbed Truck	Rental/Ownership Cost	8	weeks	$500	$4,000
Note: Heavy Equipment Cost Included in Unit Costs for Earthwork					
Other					
Project Office	Office + equipment	2	months	$750	$1,500
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	2	months	$500	$1,000
Hand tools, consumables, signage, porta cans, etc.		1	ls	$35,000	$35,000
Fuel, oil and gas for equipment		2	months	$1,500	$3,000
Housing					
Housing		2	months	$10,000	$20,000
Utilities		2	months	$1,500	$3,000
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Channel Reroute					
Clearing and Grubbing		3	AC	$10,800	$28,760
Excavation		40,000	CY	$10	$400,000
Berm Construction		1,700	CY	$4	$6,800
Spoils Placement		38,300	CY	$4	$153,200
Seeding on Spoils		180	MSF	$60	$10,800
Erosion Control on Spoils		180	MSF	$440	$79,200
Project Closeout					
Asbuilts Survey		1	ls	$15,000	$15,000
Demobilization		1	ls	$50,000	$50,000
				Subtotal	$1,223,000

General Contractor Overhead and Profit	15.0%		$184,000
General Contractor Bond & Insurance	3.0%		$37,000
Estimating Contingency	15.0%		$184,000
Inflation	3.5%		$43,000
		Construction Subtotal	$1,671,000
Design and Permitting	15.0%		$251,000
Construction Administration	8.0%		$134,000
Grant Administration	2.0%		$34,000
Estimated Total Cost (Alternative No. 1)			**$2,090,000**

Conceptual Capital Cost Estimate

Alternative No. 2 - Channel Re-route (North Route)

Project Duration **7** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Per Diem		392	day	$60	$23,520
Superintendent		7	weeks	$7,200	$50,400
Project Manager	8 hrs/week	7	weeks	$800	$5,600
Expeditor	40 hrs/week	7	weeks	$2,800	$19,600
Roundtrip Air Fare		5	each	$1,000	$5,000
Allowance for Misc Air Freight		1	ls	$25,000	$25,000
Survey		1	ls	$40,000	$40,000
Equipment Mobilization		1	ls	$210,000	$210,000
Meetings/Coordination					
Project Meetings		14	hours		$1,400
Project Schedule		2	months	$200	$400
Shop Drawings		28	hours		$2,800
Equipment					
Pickup (2 each)	Rental/Ownership Cost	7	weeks	$300	$2,100
Flatbed Truck	Rental/Ownership Cost	7	weeks	$500	$3,500
Note: Heavy Equipment Cost Included in Unit Costs for Earthwork					
Other					
Project Office	Office + equipment	2	months	$750	$1,500
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	2	months	$500	$1,000
Hand tools, consumables, signage, porta cans, etc.		1	ls	$35,000	$35,000
Fuel, oil and gas for equipment		2	months	$1,500	$3,000
Housing					
Housing		2	months	$10,000	$20,000
Utilities		2	months	$1,500	$3,000
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Channel Reroute					
Clearing and Grubbing		2	AC	$10,800	$23,802
Excavation		49,000	CY	$10	$490,000
Berm Construction		1,800	CY	$4	$7,200
Spoils Placement		47,200	CY	$4	$188,800
Seeding on Spoils		221	MSF	$60	$13,230
Erosion Control on Spoils		221	MSF	$440	$97,020
Project Closeout					
Asbuilts Survey		1	ls	$15,000	$15,000
Demobilization		1	ls	$50,000	$50,000
				Subtotal	$1,348,000

General Contractor Overhead and Profit	15.0%		$203,000
General Contractor Bond & Insurance	3.0%		$41,000
Estimating Contingency	15.0%		$203,000
Inflation	3.5%		$48,000
		Construction Subtotal	$1,843,000
Design and Permitting	15.0%		$277,000
Construction Administration	8.0%		$148,000
Grant Administration	2.0%		$37,000
Estimated Total Cost (Alternative No. 2)			**$2,305,000**

Conceptual Capital Cost Estimate

Alternative No. 3 - Channel Re-route (South Route)

Project Duration **6** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Per Diem		336	day	$60	$20,160
Superintendent		6	weeks	$7,200	$43,200
Project Manager	8 hrs/week	6	weeks	$800	$4,800
Expeditor	40 hrs/week	6	weeks	$2,800	$16,800
Roundtrip Air Fare		4	each	$1,000	$4,000
Allowance for Misc Air Freight		1	ls	$25,000	$25,000
Survey		1	ls	$40,000	$40,000
Equipment Mobilization		1	ls	$210,000	$210,000
Meetings/Coordination					
Project Meetings		12	hours		$1,200
Project Schedule		2	months	$200	$400
Shop Drawings		24	hours		$2,400
Equipment					
Pickup (2 each)	Rental/Ownership Cost	6	weeks	$300	$1,800
Flatbed Truck	Rental/Ownership Cost	6	weeks	$500	$3,000
Note: Heavy Equipment Cost Included in Unit Costs for Earthwork					
Other					
Project Office	Office + equipment	2	months	$750	$1,500
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	2	months	$500	$1,000
Hand tools, consumables, signage, porta cans, etc.		1	ls	$35,000	$35,000
Fuel, oil and gas for equipment		1	months	$1,500	$1,500
Housing					
Housing		1	months	$10,000	$10,000
Utilities		1	months	$1,500	$1,500
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Channel Reroute					
Clearing and Grubbing		2	AC	$10,800	$19,339
Excavation		13,000	CY	$10	$130,000
Berm Construction		500	CY	$4	$2,000
Spoils Placement		12,500	CY	$4	$50,000
Seeding on Spoils		59	MSF	$60	$3,510
Erosion Control on Spoils		59	MSF	$440	$25,740
Project Closeout					
Asbuilts Survey		1	ls	$15,000	$15,000
Demobilization		1	ls	$50,000	$50,000
				Subtotal	$729,000

General Contractor Overhead and Profit	15.0%		$110,000
General Contractor Bond & Insurance	3.0%		$22,000
Estimating Contingency	15.0%		$110,000
Inflation	3.5%		$26,000
		Construction Subtotal	$997,000
Design and Permitting	15.0%		$150,000
Construction Administration	8.0%		$80,000
Grant Administration	2.0%		$20,000
Estimated Total Cost (Alternative No. 3)			**$1,247,000**

Conceptual Capital Cost Estimate

Alternative No. 4 - Riprap Bank Stabilization

Project Duration **4** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Per Diem		224	day	$60	$13,440
Superintendent		4	weeks	$7,200	$28,800
Project Manager	8 hrs/week	4	weeks	$800	$3,200
Expeditor	40 hrs/week	4	weeks	$2,800	$11,200
Roundtrip Air Fare		3	each	$1,000	$3,000
Allowance for Misc Air Freight		1	ls	$25,000	$25,000
Survey		1	ls	$25,000	$25,000
Equipment Mobilization		1	ls	$210,000	$210,000
Meetings/Coordination					
Project Meetings		8	hours		$800
Project Schedule		1	months	$200	$200
Submittals		16	hours		$1,600
Equipment					
Pickup (2 each)	Rental/Ownership Cost	4	weeks	$300	$1,200
Flatbed Truck	Rental/Ownership Cost	4	weeks	$500	$2,000
Note: Heavy Equipment Cost Included in Unit Costs for Earthwork					
Other					
Project Office	Office + equipment	1	months	$750	$750
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	1	months	$500	$500
Hand tools, consumables, signage, porta cans, etc.		1	ls	$35,000	$35,000
Fuel, oil and gas for equipment		1	months	$1,500	$1,500
Housing					
Housing		1	months	$10,000	$10,000
Utilities		1	months	$1,500	$1,500
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Bank Stabilization					
Armor Stone - North Edge of Old Airport		3,670	TON	$250	$917,500
Armor Stone - East End of Old Airport		990	TON	$250	$247,500
Project Closeout					
Asbuilts Survey		1	ls	$15,000	$15,000
Demobilization		1	ls	$50,000	$50,000

Subtotal		$1,615,000
General Contractor Overhead and Profit	15.0%	$243,000
General Contractor Bond & Insurance	3.0%	$49,000
Estimating Contingency	15.0%	$243,000

Inflation	3.5%		$57,000
		Construction Subtotal	$2,207,000
Design and Permitting	10.0%		$221,000
Construction Administration	8.0%		$177,000
Grant Administration	2.0%		$45,000
Estimated Total Cost (Alternative No. 4)			**$2,650,000**

Conceptual Capital Cost Estimate

Alternative No. 4.1 - Riprap Bank Stabilization (East End of Old Airport Only)

Project Duration **2** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Per Diem		112	day	$60	$6,720
Superintendent		2	weeks	$7,200	$14,400
Project Manager	8 hrs/week	2	weeks	$800	$1,600
Expeditor	40 hrs/week	2	weeks	$2,800	$5,600
Roundtrip Air Fare		2	each	$1,000	$2,000
Allowance for Misc Air Freight		1	ls	$25,000	$25,000
Survey		1	ls	$25,000	$25,000
Equipment Mobilization		1	ls	$210,000	$210,000
Meetings/Coordination					
Project Meetings		4	hours		$400
Project Schedule		1	months	$200	$200
Submittals		8	hours		$800
Equipment					
Pickup (2 each)	Rental/Ownership Cost	2	weeks	$300	$600
Flatbed Truck	Rental/Ownership Cost	2	weeks	$500	$1,000
Note: Heavy Equipment Cost Included in Unit Costs for Earthwork					
Other					
Project Office	Office + equipment	1	months	$750	$750
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	1	months	$500	$500
Hand tools, consumables, signage, porta cans, etc.		1	ls	$35,000	$35,000
Fuel, oil and gas for equipment		0	months	$1,500	$0
Housing					
Housing		0	months	$10,000	$0
Utilities		0	months	$1,500	$0
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Bank Stabilization					
Armor Stone - East End of Old Airport		990	TON	$250	$247,500
Project Closeout					
Asbuilts Survey		1	ls	$15,000	$15,000
Demobilization		1	ls	$50,000	$50,000
				Subtotal	$652,000
	General Contractor Overhead and Profit		15.0%		$98,000
	General Contractor Bond & Insurance		3.0%		$20,000
	Estimating Contingency		15.0%		$98,000
	Inflation		3.5%		$23,000

	Construction Subtotal	$891,000
Design and Permitting	10.0%	$90,000
Construction Administration	8.0%	$72,000
Grant Administration	2.0%	$18,000
Estimated Total Cost (Alternative No. 4.1)		**$1,071,000**

Conceptual Capital Cost Estimate

Alternative No. 5 - Super Sacks Bank Stabilization

Project Duration **4** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Per Diem		224	day	$60	$13,440
Superintendent		4	weeks	$7,200	$28,800
Project Manager	8 hrs/week	4	weeks	$800	$3,200
Expeditor	40 hrs/week	4	weeks	$2,800	$11,200
Roundtrip Air Fare		3	each	$1,000	$3,000
Allowance for Misc Air Freight		1	ls	$25,000	$25,000
Survey		1	ls	$25,000	$25,000
Equipment Mobilization		1	ls	$210,000	$210,000
Meetings/Coordination					
Project Meetings		8	hours		$800
Project Schedule		1	months	$200	$200
Submittals		16	hours		$1,600
Equipment					
Pickup (2 each)	Rental/Ownership Cost	4	weeks	$300	$1,200
Flatbed Truck	Rental/Ownership Cost	4	weeks	$500	$2,000
Note: Heavy Equipment Cost Included in Unit Costs for Earthwork					
Other					
Project Office	Office + equipment	1	months	$750	$750
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	1	months	$500	$500
Hand tools, consumables, signage, porta cans, etc.		1	ls	$35,000	$35,000
Fuel, oil and gas for equipment		1	months	$1,500	$1,500
Housing					
Housing		1	months	$10,000	$10,000
Utilities		1	months	$1,500	$1,500
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Bank Stabilization					
Super Sacks - North Edge of Old Airport		1,860	CY	$35	$65,100
Super Sacks - East End of Old Airport		500	CY	$35	$17,500
Infill Old Airport Runway		12,600	CY	$3	$37,800
Project Closeout					
Asbuilts Survey		1	ls	$15,000	$15,000
Demobilization		1	ls	$50,000	$50,000

Subtotal		$570,000
General Contractor Overhead and Profit	15.0%	$86,000
General Contractor Bond & Insurance	3.0%	$18,000

Estimating Contingency	15.0%	$86,000
Inflation	3.5%	$20,000
	Construction Subtotal	$780,000
Design and Permitting	10.0%	$78,000
Construction Administration	8.0%	$63,000
Grant Administration	2.0%	$16,000
Estimated Total Cost (Alternative No. 5)		**$937,000**

Conceptual Capital Cost Estimate

Alternative No. 5.1 - Gabion Basket Bank Stabilization

Project Duration **4** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Per Diem		224	day	$60	$13,440
Superintendent		4	weeks	$7,200	$28,800
Project Manager	8 hrs/week	4	weeks	$800	$3,200
Expeditor	40 hrs/week	4	weeks	$2,800	$11,200
Roundtrip Air Fare		3	each	$1,000	$3,000
Allowance for Misc Air Freight		1	ls	$25,000	$25,000
Survey		1	ls	$25,000	$25,000
Equipment Mobilization		1	ls	$210,000	$210,000
Meetings/Coordination					
Project Meetings		8	hours		$800
Project Schedule		1	months	$200	$200
Submittals		16	hours		$1,600
Equipment					
Pickup (2 each)	Rental/Ownership Cost	4	weeks	$300	$1,200
Flatbed Truck	Rental/Ownership Cost	4	weeks	$500	$2,000
Note: Heavy Equipment Cost Included in Unit Costs for Earthwork					
Other					
Project Office	Office + equipment	1	months	$750	$750
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	1	months	$500	$500
Hand tools, consumables, signage, porta cans, etc.		1	ls	$35,000	$35,000
Fuel, oil and gas for equipment		1	months	$1,500	$1,500
Housing					
Housing		1	months	$10,000	$10,000
Utilities		1	months	$1,500	$1,500
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Bank Stabilization					
Gabion Baskets - North Edge of Old Airport		1,860	CY	$350	$651,000
Gabion Baskets - East End of Old Airport		500	CY	$350	$175,000
Infill Old Airport Runway		12,600	CY	$3	$37,800
Project Closeout					
Asbuilts Survey		1	ls	$15,000	$15,000
Demobilization		1	ls	$50,000	$50,000

Subtotal		$1,313,000
General Contractor Overhead and Profit	15.0%	$197,000
General Contractor Bond & Insurance	3.0%	$40,000

Estimating Contingency	15.0%		$197,000
Inflation	3.5%		$46,000
		Construction Subtotal	$1,793,000
Design and Permitting	10.0%		$180,000
Construction Administration	8.0%		$144,000
Grant Administration	2.0%		$36,000
Estimated Total Cost (Alternative No. 5.1)			**$2,153,000**

Conceptual Capital Cost Estimate

Alternative No. 6 - Alt 1 Channel Re-route (Mid Route) & Alt 4 Bank Stabilization (Riprap)

Project Duration **10** **weeks**

ACTIVITY	NOTES	QUANTITY	UNIT	UNIT COST	TOTAL COST
General					
Per Diem		560	day	$60	$33,600
Superintendent		10	weeks	$7,200	$72,000
Project Manager	8 hrs/week	10	weeks	$800	$8,000
Expeditor	40 hrs/week	10	weeks	$2,800	$28,000
Roundtrip Air Fare		7	each	$1,000	$7,000
Allowance for Misc Air Freight		1	ls	$25,000	$25,000
Survey		1	ls	$40,000	$40,000
Equipment Mobilization		1	ls	$210,000	$210,000
Meetings/Coordination					
Project Meetings		20	hours		$2,000
Project Schedule		2.5	months	$200	$500
Shop Drawings		32	hours		$3,200
Equipment					
Pickup (2 each)	Rental/Ownership Cost	10	weeks	$300	$3,000
Flatbed Truck	Rental/Ownership Cost	10	weeks	$500	$5,000
Note: Heavy Equipment Cost Included in Unit Costs for Earthwork					
Other					
Project Office	Office + equipment	2.5	months	$750	$1,875
Safety Equipment		1	ls	$5,000	$5,000
Temporary Power	Generators for Tools	2.5	months	$500	$1,250
Hand tools, consumables, signage, porta cans, etc.		1	ls	$35,000	$35,000
Fuel, oil and gas for equipment		2.5	months	$1,500	$3,750
Housing					
Housing		2.5	months	$10,000	$25,000
Utilities		2.5	months	$1,500	$3,750
Insurance					
Certified Payroll Fee		1	ls	$5,000	$5,000
Channel Reroute					
Clearing and Grubbing		3	AC	$10,800	$28,760
Excavation		40,000	CY	$10	$400,000
Berm Construction		1,700	CY	$4	$6,800
Spoils Placement		38,300	CY	$4	$153,200
Seeding on Spoils		180	MSF	$60	$10,800
Erosion Control on Spoils		180	MSF	$440	$79,200
Bank Stabilization					
Armor Stone - North Edge of Old Airport		3,670	TON	$250	$917,500
Armor Stone - East End of Old Airport		990	TON	$250	$247,500
Project Closeout					
Asbuilts Survey		1	ls	$15,000	$15,000
Demobilization		1	ls	$50,000	$50,000
				Subtotal	$2,427,000

General Contractor Overhead and Profit	15.0%		$365,000
General Contractor Bond & Insurance	3.0%		$73,000
Estimating Contingency	15.0%		$365,000
Inflation	3.5%		$85,000
		Construction Subtotal	$3,315,000
Design and Permitting	15.0%		$498,000
Construction Administration	8.0%		$266,000
Grant Administration	2.0%		$67,000
Estimated Total Cost (Alternative No. 6)			**$4,146,000**